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1986

VEGETABLE Production Recommendations

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1986 VEGETABLE PRODUCTION RECOMMENDATIONS

In this publication most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first, unless otherwise indicated. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that in some cases the most effective pesticides are highly toxic. A list of the brand and trade names of pesticides recommended in this publication is given in the centrefold.

The effectiveness of pesticides, and plant injury by control chemicals, are influenced by the weather and other conditions. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable of soluble powder (WP, AP, SP, or W) preparations generally are less likely to cause plant injury than liquid concentrate (EC, SC, and F) formulations.

The amounts of materials stated in the recommendations are for each hectare actually covered, unless otherwise stated. The amount of water used per hectare in ground spray equipment may vary depending on the pest to be controlled and type of equipment.

Recommendations are for the 1986 season and may be revised whenever further information is available. Discard old editions. The pesticide recommendations are for **commercial** plantings. Home gardeners should use products and methods recommended for home gardens, as given in Ontario Ministry of Agriculture and Food Publication 64, *Insect and Disease Control in the Home Garden.*

For advice related to pests, spray mixtures, spraying, and timing of applications, consult the Crop Advisor or Pest Management Specialist serving your area (page 2).

For additional production information refer to Publications for Vegetable Growers (page 67).

SPRAY-TANK MIXTURES IN ALKALINE WATER

Because many pesticides are susceptible to alkaline water[1], it is recommended that pesticides diluted with alkaline water be used immediately.

However, "spray immediately" is not always possible owing to unexpected reasons: rain, wind, sickness etc. Any delay in applying spray mixtures will result in pesticide loss due to degradation[2] and possibly a corresponding decrease in control.

To avoid this possibility, it is recommended that alkaline water be neutralized before adding any pesticides. Dissolve potassium or ammonium dihydrogen phosphate[3] at the rate of 50 g per 100 litres of water, and then add pesticides.

The phosphate is not always necessary, but this practice is a sort of insurance. The cost of the phosphate is substantially less than that of the pesticides. Also, the added phosphate will be available as a foliar nutrient.

Occasionally water-soluble fertilizers are used with pesticides as a tank mixture. This practice is not encouraged because most of the water-soluble fertilizers are strongly alkaline. If these fertilizers are used, the amount of phosphate recommended is not sufficient to neutralize the water.

1. *Most of the water being used in the Holland Marsh and many water sources in the Niagara Peninsula are fairly alkaline (pH 7.5 - 9.0). Possibly, there are other areas in Ontario where alkaline water is being used.*
2. *The rate of degradation is dependent on the pesticide, the concentration of pesticide in the tank (dilution factor), and pH and temperature of the water.*
3. *The phosphate is available from limited suppliers. The cost of ammonium dihydrogen phosphate is $1.50 per kg (as of October 1985). For 100 L of water, the cost (50 g of phosphate) is 7.5 cents.*

TEMPORARY REGISTRATION OF PESTICIDES

Temporary registration of a pesticide is a procedure which is frequently used prior to full registration. Temporary registration is only granted for a period of one calendar year. On December 31 of each year, the temporary registration status ceases. After that time, the pesticide may be discontinued, have the temporary registration extended, or be granted full registration.

As of the printing date of this publication, the pesticides indicated with a (**) were registered on a temporary basis for use in 1985. The fate of these materials has not been fully determined for 1986. Growers are urged to check the registration status of these pesticides prior to use. If a pesticide is no longer registered, it is no longer legal to use it. A pesticide should not be used on any crop unless it has been registered for that crop.

Pesticides with a temporary registration and listed in this publication in 1985 include Ridomil/MZ 72W, Thuricide HPC, Decis 2.5 EC, and Belmark 300 EC.

REFER TO CENTERFOLD FOR LIST OF BRAND AND COMMON NAMES OF PESTICIDES

CONTENTS

GENERAL

Abbreviations 67
Acknowledgments 67
Compatibility Chart 8
Chemical Seed Treatment 26
Climate of Ontario 9
Crop Advisors and Pest-Management Specialists 2
Crop Insurance 7
Crop Rotation for Control of Diseases 25
Cutworms 24
Damping-off of Seedlings 27
Fertilizers (and Soil Management) 13
Growth Regulators 22
Hot-Water Seed Treatment 26
Irrigation 23
Metric Information 69-71
Nematodes 25
Number of Plants per Hectare 11
Pesticides-Control Field Offices 66
Pesticide Names .... Centerfold
Pesticide Resistance 1
Plant Population and Precision Seeding 12
Precautions with All Pesticides 3
Publications for Vegetable Growers 67
Residue Tolerances and Days to Harvest 7
Safety Supply Companies 4
Seeds — Planting Depth and Number per Gram 11
Slugs 24
Soil Management and Fertilizer Use 13
Spray-Tank Mixtures in Alkaline Water .... Inside Front Cover
Weed Control (General) 12
White Grubs 24
Wireworms 25

CROPS

Asparagus 28
Bean (Snap and Lima) 29
Beet 31
Broccoli 32
Brussels Sprouts 32
Cabbage 32
Carrot 35
Cauliflower 32
Celery 38
Corn (Sweet) 39
Cucumber (Fresh Market) 42
Cucumber (Processing) 44
Eggplant 45
Lettuce 46

Muskmelon 42
Onion 48
Parsnip 51
Pea 51
Pepper 52
Potato 54
Pumpkin 42
Radish 58
Rhubarb 58
Rutabaga 59
Spinach 61
Squash 42
Tomato 62
Watermelon 42

PESTICIDE RESISTANCE

Many of the pesticides recommended have a very specific mechanism of action; that is, they act on a single system or site in the organism. These materials **should not be used continuously and repeatedly** in a season-long program since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate, Lannate, the pyrethroids (Ambush, Belmark, Pounce), etc.

In our recommendations we suggest that such compounds be used **in combination with other pesticides or that they be alternated with other pesticides** so that the likelihood of resistance development is reduced.

It should be noted that several pesticides may act similarly. Thus, parathion and Guthion, for example, act on the same site, and if resistance develops to one, it is likely to apply also to the other. (This is called cross-resistance.) Thus, alternating these compounds will not be useful. Rather, they should be alternated with insecticides with different modes of action; for example, Thiodan or methoxychlor.

HORTICULTURAL CROP ADVISORS
ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Counties or Area Served	Name	Address	Phone No.
Eastern Ontario	Steve Rowe	College of Agricultural Technology, Kemptville K0G 1J0	613-258-3411
Prince Edward, Hastings, Lennox, Addington, Frontenac	Jody Bodnar	P.O. Box 470, Picton K0K 2T0	613-476-3224
Northumberland, Peterborough	Dave Ridgway	P.O. Box 340, Trenton K8V 5R5	613-392-3527
Durham, Victoria-Haliburton, Ontario	Bengt Schumacher	234 King Street East, Bowmanville L1C 1P5	416-623-3348
North York (Bradford Marsh Area)	Matt Valk*	Muck Research Station, R.R. No. 1, Kettleby L0G 1J0	416-775-3783
Simcoe, Dufferin, Grey	Ken Wilson	P.O. Box 69, Clarksburg N0H 1J0	519-599-2042
Halton, Peel, Wellington, North Wentworth	Joe Uyenaka	17 Wilson Drive, Milton L9T 3J7	416-878-2314
Niagara Peninsula	Ian Smith, Burke McNeill	Vineland Station L0R 2E0	416-562-4142
Norfolk, Brant	———	P.O. Box 587, Simcoe N3Y 4N5	519-426-7120
Oxford, Elgin, Perth, Waterloo	Keith Priest	P.O. Box 666, Woodstock N4S 7Z5	519-537-6623
Lambton, Middlesex, Huron	John Gardner	60 King St., London N6A 2P2	519-434-6811
Essex, Kent	Ed Tomecek	College of Agricultural Technology, Ridgetown N0P 2C0	519-674-5456
Essex, Kent	Clem Fisher, Leslie Huffman	Research Station, Harrow N0R 1G0	519-738-2251
Potato Specialist	Sam Squire	P.O. Box 370, Alliston L0M 1A0	705-435-5521
Floriculture Specialist (Greenhouse Flowers)	John Hughes	Dept. of Horticultural Science, University of Guelph, Guelph N1G 2W1	519-824-4120 Ext. 8910
Floriculture and Nursery Specialist	Wayne Brown	Vineland Station L0R 2E0	416-562-4141
Marketing Specialist	Bob Cobbledick	Vineland Station L0R 2E0	416-562-4142

**Horticultural Research Institute of Ontario staff*

PEST MANAGEMENT SPECIALISTS

Durham and Counties Eastward	Cathy McKay	234 King St. East Bowmanville, L1C 1P5	416-623-3348
York (Muck Vegetable Crops)	Mary Ruth McDonald	Muck Research Station R.R. 1, Kettleby, L0G 1JO	416-775-4261
Niagara Peninsula	Kevin Ker, Gerald Walker	Vineland Station, L0R 2E0	416-562-4142
Halton County and westward, including Oxford	Pam Fisher	P.O. Box 587, Simcoe N3Y 4N5	519-426-7120
Elgin County and westward, including Essex	Alison Smith	60 King St., London, N6A 2P2	519-434-6811
Extension Plant Pathologist (Southern Ontario)	Craig Hunter	P.O. Box 587, Simcoe N3Y 4N5	519-426-7120

If a problem arises in connection with special pests, spray mixtures or spraying, and other cultural practices, telephone or write the Horticultural Crop Advisor or Pest Management Specialist serving your area.

AGRIPHONES — for regularly up-dated recorded messages

Georgian Bay	519-599-2915	Milton	416-876-1383	Woodstock	519-537-7161
Kingsville	519-733-3151	Newmarket	416-775-3493	St. Catharines	416-684-6684
Chatham	519-352-0222	Smithfield	613-392-3422	London	519-438-1014
Simcoe	519-426-7810	Vineland	416-562-4345	Bowmanville	416-623-4944
				Kemptville	613-258-5836

PRECAUTIONS WITH ALL PESTICIDES

Read this entire section before using any pesticides.

1. Always read the label before opening pesticide containers, and follow all precautions and directions.
2. Never smoke, chew tobacco or eat while handling or applying pesticides. **Do not** carry such items in clothes used for spraying.
3. Always wear neoprene gloves to handle concentrates and when coming in contact with dilute spray, i.e. cleaning nozzles, and pumps, and handling contaminated spray equipment.
4. Inhalation of spray droplets, dust or fumes should be avoided. Wear a respirator to reduce pesticide inhalation, especially when handling dusty formulations or volatile concentrates. For gases a self-contained breathing apparatus may be required.
5. Wear freshly laundered clothes each day, including caps. Regularly wash gloves and boots. Avoid spilling pesticides on skin or clothing.
6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing spray equipment. Never fill a sprayer directly from a stream, pond or well unless the unit is equipped with an anti-backflow device to prevent siphoning.
7. Keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident. See the centerfold in this publication.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash all clothing including caps, gloves and boots before reuse.
2. If clothing becomes wet with a pesticide, when spraying, remove it immediately. When the spray operation is complete, remove all contaminated clothes including underclothes, have a bath or shower and put on freshly laundered clothing.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common-name chemicals with you to the hospital (see Emergency Procedures for Pesticide Poisoning)
4. Clean up any pesticide spills immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice (page 66).
5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Avenue, Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted:

Between 8:00 a.m. and 5:00 p.m., Monday to Friday. Telephone **(416) 965-3610.**

During weekends, public holidays and non-office hours. Telephone **(416) 965-1211** and ask for the "on-call" physician.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled on clothing or parts of the body, remove clothing including under-garments and wash skin and hair with water, or soap and water if available. Flush eyes with plenty of water.

Should a person exhibit symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being used. Get this from the label or from the list mentioned below, or refer to the centerfold in this publication.

RELATIVE HAZARDS TO HUMANS OF RECOMMENDED PESTICIDES FOR VEGETABLES

These pesticides are dangerous if inhaled, gotten on skin, or taken by mouth. A few grams can be fatal. Wear protective clothing (page 4), avoid mixing in windy areas, dispose of containers properly (page 6) and always wash or bathe and change clothing immediately after use. Since methyl bromide is a poisonous gas, special precautions are needed. A permit is required, and regulations governing its use are found in the Pesticides Act and Regulations.

Extreme Hazard

Aldicarb (Temik)
Azinphos-methyl (Guthion, APM 50)
Carbofuran (Furadan)
Chlorfenvinphos (Birlane)
Chloropicrin (Telone C-17, Vorlex CP, MB-C2)
Demeton (Systox)
Dinoseb
Disulfoton (Di-Syston)
Fensulfothion (Dasanit)
*Methyl Bromide (MC-2, MB-C2)
Methamidophos (Monitor)
Mevinphos (Phosdrin)
Oxamyl (Vydate)
Parathion
Phorate (thimet)
Telone II (DCP)
Telone C-17 (DCP + Chloropicrin)
Vorlex (DCP + Methyl isocyanate)
Vorlex CP (DCP + Methyl isocyanate)
All greenhouse smokes and fogs, etc.

**Permit required for use.*

Moderate Hazard

These pesticides are dangerous if handled carelessly. Caution is required to ensure that they are not taken internally or allowed to contact skin. Wear protective clothing, including respirator and goggles, when mixing or working with them. Avoid breathing the fumes. Wash or bathe and change clothing after applying these materials. Triple rinse and dispose of containers properly (page 6).

Captan*
Deltamethrin (Decis)
Dimethoate (Cygon)
Diazinon (Basudin)
Endosulfan (Thiodan)
Lindane
Oxydemeton-methyl (Metasystox-R)
Phosmet (Imidan)
Permethrin (Ambush)
Pirimicarb (Pirimor)

**Current studies indicate that captan requires special handling procedures as outlined on the label. Therefore, follow directions closely.*

Low Hazard

Pesticides listed in this publication and not appearing on this list are less toxic, but should be handled with all precautions listed on the label. Even the most toxic pesticide can be used safely, if used properly, by following all directions and precautions listed on the label.

SPECIAL INSTRUCTIONS

It should be emphasized that all pesticides are toxic and must be handled carefully. In addition, a number of pesticides (insecticides, fungicides and herbicides) have major deficiencies in their toxicological information because many of the tests that were conducted by the Industrial Biotest Laboratory (IBT) were invalid. Replacement studies are currently being conducted by the respective registrants. Those handling and applying these chemicals must pay special attention to the precautions outlined above.

At the time of printing, pesticides included in this publication *(1986 Vegetable Production Recommendations)* requiring additional studies are as follows:

Common Name	Trade Name
captafol	Difolatan
endosulfan	Thiodan
ethion	Ethion
methamidophos	Monitor
methidathion	Supracide
naled	Dibrom

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of suppressing and inactivating the serum and red blood cholinesterase levels. If the activity of the cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value, the tests should be commenced **before** using these pesticides and not after applications have begun, since the normal cholinesterase level per individual can vary considerably, making if difficult to assess the degree of suppression. In this publication the primary insecticides of concern are those listed as extremely and moderately hazardous under Relative Hazards to Humans.

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. It is recommended that neoprene or rubber gloves, rubber boots, a protective apron or coverall, and protective eyeshields be worn to reduce the risk of dermal exposure when measuring, mixing and loading pesticides.

   Protective clothing, including disposable gloves, aprons or overalls and hat covers, are available at reasonable prices from the major safety supply companies listed below.
2. Wash all clothing after use. Wear freshly laundered clothes each day.
3. Although recommended when loading and handling concentrates, the wearing of dual-cartridge chemical respirators is neither mandatory nor required with all pesticides or under all conditions of pesticide use. If a label specifies respiratory protection, follow the directions closely. A wide range of respiratory protection from certain pesticides is available from the major safety supply companies who offer both full and half-face models in varying sizes. Consult the safety supply company of your choice for appropriate guidance and selection.

SAFETY SUPPLY COMPANIES IN ONTARIO PROVIDING PROTECTIVE CLOTHING AND/OR RESPIRATORY DEVICES FOR OUTDOOR PROTECTION AGAINST CERTAIN PESTICIDES

Respiratory Devices Manufactured By:	Available From:
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 60 Mobile Drive, Toronto, M4A 2R7. Tel (416) 752-8780 Branches: Hamilton & Belleville.
H.S. Cover (York)	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Kasco Helmets	The St. George Co., St. George, N0E 1N0 Tel. (519) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York, M3N 1X8, Tel. (416) 667-9400
3M Occupational Health & Safety Products Div.	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
North	Siebe-North Inc., 26 Dansk Court, Rexdale, M9W 5V8, Tel. (416) 675-2790

(Continued on Page 5)

SAFETY SUPPLY COMPANIES IN ONTARIO PROVIDING PROTECTIVE CLOTHING AND/OR RESPIRATORY DEVICES FOR OUTDOOR PROTECTION AGAINST CERTAIN PESTICIDES (continued)

Racal Airstream	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
Safety House	Safety House of Canada Ltd., 1275 Castlefield Ave., Toronto, M6B 1G4, Tel. (416) 789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines and Stoney Creek.
Scott	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor
Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay
Willson	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, South Porcupine, Thunder Bay and Windsor.

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES AND OTHER ENCLOSED AREAS

Respiratory Protection - Available Devices

Air-Purifying Devices - Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Working Conditions

High Concentrations

(a) Use only a self-contained breathing apparatus e.g. Scott Air Pak.

(b) High concentration of toxic gases, vapors or particulate matter can be produced when dispensing extremely or highly toxic pesticides such as parathion, nicotine, naled (Dibrom), Vorlex and Telone
  (i) through fogging machines
  (ii) by means of smoke bombs
  (iii) as spray applications.

In such instances self-contained breathing apparatus is recommended.

Low Concentrations

Canister gas masks may be used when the ambient air contains low concentrations of toxic gases, vapors or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exceptions include aldicarb (Temik 10G) and fensulfothion (Dasanit 15G) but the wearing of canister gas masks provides protection.

Contact your safety supply company for the proper canister selection.

Other Clothing

When measuring, mixing and applying pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, hat, and protective eyeshields or a full-face mask.

METHYL BROMIDE AND INSECTICIDE SMOKES

A permit issued by the Ontario Ministry of the Environment is necessary to use methyl bromide (MC-2 and MB-C2). To apply for a permit contact:

Agricultural and Industrial Chemicals Section
Ontario Ministry of the Environment
135 St. Clair Avenue West
Toronto, Ontario M4V 1P5
Telephone: (416) 965-2401

When using methyl bromide or insecticide smoke generators, suitable protective clothing must be worn. After treatment, the greenhouse must be barricaded and warning signs posted. In general, smokes are especially useful for small greenhouses of 930 m^2 or less. Smoke applications are not satisfactory for spot treatment.

REENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling the treated plants or from inhalation of pesticide fumes.

The following pesticides are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g., parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended.

24 Hours	*48 Hours*	*7 Days*
Mevinphos (Phosdrin)	Aldicarb (Temik)	Parathion
Methidathion (Supracide)	Azinphosmethyl (Guthion)	
Methomyl (Lannate)	Carbofuran (Furadan)	
Oxamyl (Vydate)	Chlorfenvinphos (Birlane)	
	Demeton (Systox)	
	Fensulfothion (Dasanit)	
	Methamidophos (Monitor)	
	Oxydemeton-methyl (Metasystox-R)	

STORAGE

1. **General Storage:**

   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans, and feed for animals.

   Herbicides should be stored separately from other pesticides to avoid possible contamination.

2. **Special Storage:**

1. Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING — AUTHORIZED PERSONNEL ONLY" in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.
2. **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** See also OMAF Factsheet, *Farm Storage of Pesticides*, Agdex 607.
3. Post pesticide storage areas with proper notices.
4. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high-water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems affecting humans and domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS AND CONTAMINATED MATERIAL

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or public outdoor areas.
2. Un-rinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply.) Failure to rinse is also wasteful — why not use that 3% for the purpose for which it was purchased, i.e., to control the pest!

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residue left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers should be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, and reduce the amount of material in the target area so that it is ineffective.

Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

1. correct calibration and maintenance of spray equipment
2. correct operation of the equipment
3. being aware of the toxicity of the pesticide being used
4. being aware of the weather conditions.

For more information consult OMAF Factsheet, *Pesticide Drift*, Agdex 607, or Canadex 607, *Pesticides: effects of drift and droplet size.*

PESTICIDE APPLICATION BY AIRPLANE OR HELICOPTER

Aerial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offence under the Federal Pest-Control Products Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g. Sevin (carbaryl).

Applications should not be made if the wind is blowing. Even on the stillest day, some drift occurs; to keep it to a minimum apply pesticides in the evening or early morning.

Be sure that the contract specifies the product to be used and its rate of application.

RESIDUE TOLERANCES AND DAYS TO HARVEST

Tolerances for residues of agricultural chemicals on vegetables when offered for sale have been set by Health and Welfare Canada.

To avoid exceeding the residue tolerance for insecticides, herbicides, and fungicides:

- DO NOT APPLY THEM LATER THAN RECOMMENDED.
- DO NOT APPLY MORE THAN THE RECOMMENDED AMOUNT.
- DO NOT APPLY THEM MORE OFTEN THAN RECOMMENDED ON THE LABEL.

When controlling insects, for example, **do not apply an insecticide later than the number of days from harvest given in brackets after the recommendation.** Malathion 25% WP 4.5 kg (7 days) indicates that the malathion spray should not be used later than 7 days before the beginning of harvest, and that no more than 4.5 kg of a wettable-powder formulation containing 25% malathion should be used for one hectare of crop in an application.

CROP INSURANCE

The Government of Ontario in co-operation with the Government of Canada has developed a comprehensive scheme of crop insurance protection. The Canada-Ontario Crop Insurance Program is administered by the Crop Insurance Commission of Ontario. The Government of Canada provides financial assistance to this program by contributing 50% of the total required premium each year. In 1985 the contribution by the federal government amounted to 21 million dollars.

The Government of Ontario contributed 3.8 million dollars for administering the program in 1985. As a result, this valuable protection is available to Ontario growers at less than half the total cost. The premium is also an operating expense for income tax purposes.

Crop insurance offers protection against loss from a broad range of production hazards including excessive rain, excessive drought, winter damage, frost, hail, wind, certain pests and diseases, etc.

Crops for which a crop insurance plan is available in Ontario include:

Vegetables

Asparagus
*Beans (green and wax, processing only)
Beets
Broccoli
Cabbage
Carrots
Cauliflower
Celery
Cucumbers
Lettuce
*Lima beans (processing only)
Parsnips
*Peas (processing only)
Peppers
Potatoes
Pumpkins
Rutabagas
Seed onions
Set onions
Spanish onions
Squash
Sweet corn (fresh)
*Sweet corn (processing)
Tomatoes
*Tomatoes (processing)

Fruit Crops

Apples
Grapes
Peaches
Pears
Plums
Sour cherries
Strawberries
Sweet cherries

General Crops

Canola
Corn (grain and silage)
Hay
New forage seeding
Seed corn
Spring grain
Soybeans
White beans
Colored beans
Winter wheat

Tobacco

Flue-cured
Burley
Black

**Insurance contracts are available through processing companies only. Insurance contracts for all other crops are available from Crop Insurance agents only.*

For further information contact your local crop insurance agent or:

The Crop Insurance Commission of Ontario,
Ministry of Agriculture and Food,
Legislative Buildings,
Toronto, Ontario M7A 1B7.

COMPATIBILITY OF INSECTICIDES AND FUNGICIDES

The chart below is only a **guide** to mixing of spray materials.

Consult the manufacturer's label regarding compatibility of products with other pesticides. Compatibilities of some materials depend upon solvents and emulsifiers used by the manufacturer. As all manufacturers do not use the same solvents and emulsifiers, **be sure to check the label or product being used for compatibility.**

Chart applies **only to the use of two-material spray combinations.** When three or more materials are tank-mixed together, further incompatibility may develop.

COMPATIBILITY-CHART KEY

When a blank appears on the chart, the materials usually are not used together or the compatibility is not known.

+ May be used together
— Do not use together
OP Organo-phosphorus compound
1 Use WP formulations
2 Apply immediately with tank agitation
3 Use with caution (possible plant injury)

Special Notes

- Do not mix pesticides with foliar fertilizers.
- Do not allow spray mixtures to stand overnight before using.
- Fixed copper is generally not compatible with OP compounds.
- *Bacillus thuringiensis* is generally compatible with most insecticides and fungicides if mixed in the tank just prior to application.
- Rotenone breaks down in sunlight.
- When mixing a wettable powder and emulsifiable concentrate, put the powder into solution first.

		Ambush	Belmark	Benlate	Bravo	captan, Difolatan	Copper (fixed)	Cygon	Cymbush,	Decis	diazinon	Dibrom	Dyrene	Easout	Furadan	Guthion, APM	Imidan	Kelthane	Lannate	Lorsban	malathion, parathion	dithiocarbamates	Metasystox-R	methoxychlor	Monitor	Phosdrin	Pirimor	Polyram	Pounce	Ridomil/MZ	rotenone	Rovral	Sevin	Systox	Supracide	Thiodan, Endosulfan
Ambush																																				
Belmark																																				
Benlate		+	+																																	
Bravo		+	+	+																																
captan, Difolatan		+	+	+	+																															
Copper (fixed)		+		—	+	2																														
Cygon	OP			+	+	+	+																													
Cymbush,				+	+	+	+																													
Decis						—																														
diazinon	OP			+	1	+	2	+																												
Dibrom	OP			+	+	1	+	+			+																									
Dyrene				+	+		+	+				+																								
Easout		+	+	+			—	3	+		+																									
Furadan				+	+	+							+	+																						
Guthion, APM	OP			+	1	1	+	+			+		+	+																						
Imidan	OP	+		+	+	+		+	+			+		+		+																				
Kelthane		+		+		1	+	+	+		+	+	+	+		+	+																			
Lannate				+	3	+	+	+			+	+	3	+		+	3	+																		
Lorsban																																				
malathion, parathion	OP			+	1	1	+	+			+	+	+	+		+	+	+	+																	
dithiocarbamates		+	+	+	+	+	2	+	+		2	+	+	+	+	1	+	+	+		2															
Metasystox-R	OP			+	+	+	+	+			+	+	+			+	+	+	+		+	+														
methoxychlor				+	+	1	+	+			+	+	+	+		+	+	+	+		+	1	+													
Monitor	OP			+	+	1	+	+			+		+			+	+	+	+		+	+	+	+												
Phosdrin	OP			+	+	+	+	+			+	+	+	+		+	+	+	+		+	+	+	+	+											
Pirimor		+		+	3	+			+		+			+		+	+		+			+	+		+	+										
Polyram		+	+	+			—	+	+		2			+	—	+	+	+	+		2	+		1		+	+									
Pounce								+						+											+	+		+								
Ridomil/MZ		+	+					+		+					+	+	+			+			+		+		+									
rotenone				—	+	+	+	+			+	+	+			+	+	+	3		+	+	+	+	+	+		+								
Rovral		+						+	+		+	+				+			+			+														
Sevin				+	+	+	—	+			+	+	+	+		+	+	+	+		+	+	+	+	+		+	+	+		+	+				
Systox	OP			+	+	+	+	+			+	+	+	+		+	+	+	+		+	+		+	+	+	+	+			+		+			
Supracide	OP			+	—	+		+			—			+	+	+		+				+	+					+		+			+			
Thiodan, Endosulfan					+	+	1	+			+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+			+	+	+	+	+	
Vydate		+	+	+	+	+	—	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+

maneb, zineb, ferbam, mancozeb.

CLIMATE OF ONTARIO

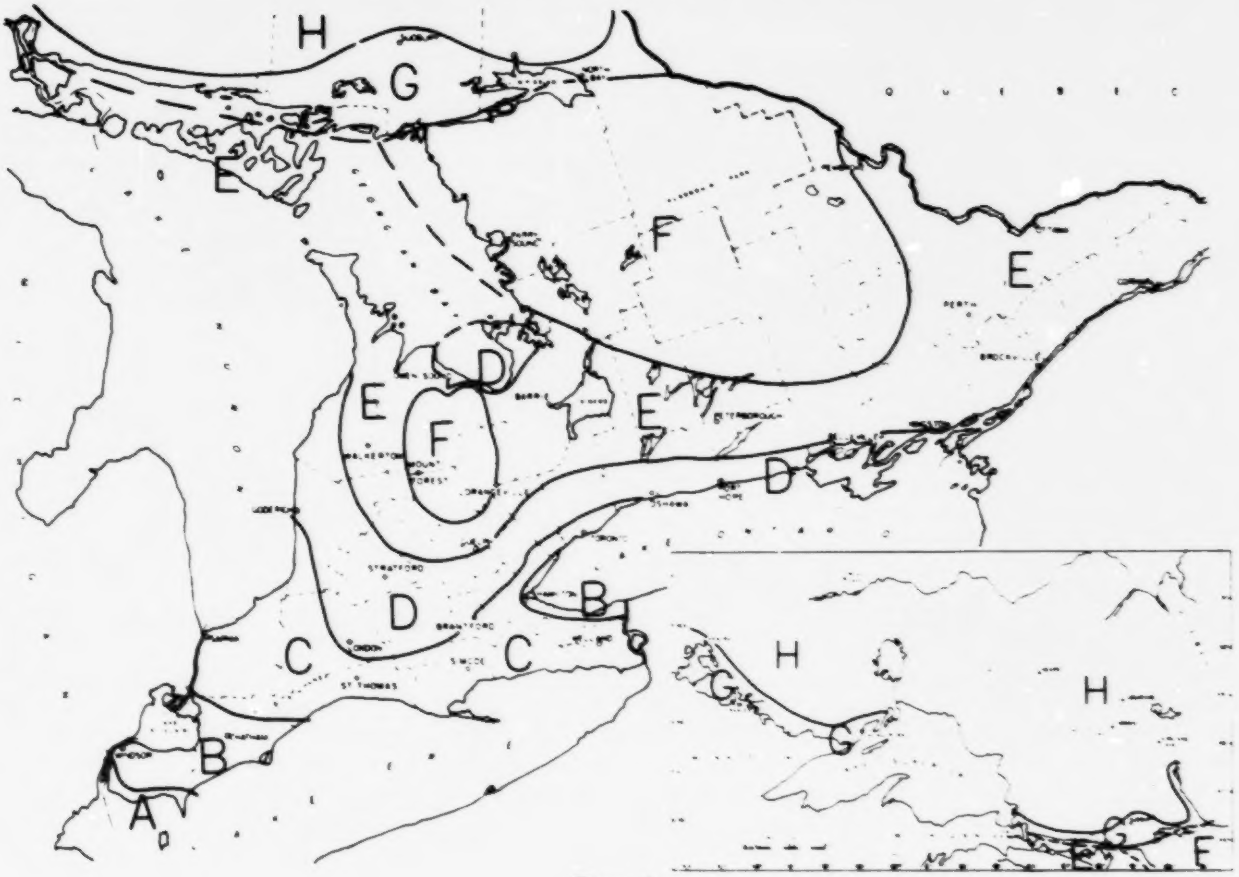

Figure 1

Most vegetable production is concentrated in southern Ontario. There are differences in climate even in this small area, particularly in the length of the growing season and in average temperatures.

Figure 1 is a Zonation Map of southern Ontario. Zone A has the longest growing season and is the small region in the Leamington-Harrow-Amherstburg area bordering on Lake Erie. The other zones are progressively shorter in growing season. The zone lines are approximate and do not represent sharp changes in climate. The gradation of temperature and growing season from one zone to another is gradual.

TABLE 1. AVERAGE FROST-FREE PERIOD IN CLIMATIC ZONES OF ONTARIO

Zone	Average frost-free period (days)	Average date of last spring frost	Average date of first fall frost
A	165 or more	May 1	October 13
B	155-165	May 8	October 10
C	150-155	May 11	October 7
D	140-150	May 15	October 2
E	120-140	May 22	September 25
F	110-120	June 1	September 17
G	95-110	June 8	September 12
H	95 or less	After May 31	Before September 10

Table 1 gives approximate growing periods for tender crops and average dates of first and last frost (0°C) in each zone. These average frost dates are approximate guides to the beginning and end of the frost-free period in 5 out of 10 years. For example, in past records from Zone C the last spring frost still occurred later than May 11, or the first fall frost occurred before October 7, in 5 out of 10 years. This 5-out-of-10 risk level may be excessive for planning many farm operations, so frost dates with lower risk levels may be determined as follows. Three years in 10 the first frost will occur about one week later in the spring or one week earlier in the fall than the date given in Table 1. For the 1-year-in-10 risk, the dates in Table 1 should be adjusted about 2 weeks later in spring and 2 weeks earlier in fall. For example, 1 year in 10 the last spring frost in Zone C has occurred later than May 25 or the first fall frost has occurred earlier than September 24.

Table 1 and the above paragraph refer to the occurrences of 0°C at a standard height of 1.5 metres at which time tender crops will often be damaged. Frost-hardier crops are not usually damaged until temperatures at this level drop below — 2°C. The date of occurrence of — 2°C is usually about 2 weeks earlier in the spring or later in the fall than the date of 0°C.

It is obvious that there are many local variations due to topography, altitude, natural air drainage and nearness to water that influence growing conditions. Cold air tends to flow, like water, into low-lying areas. Plants may be frost damaged at the bottom of a slope and not have been injured on the slope or at the top of the hill.

Particularly during spring a south-facing slope or an area surrounded by a windbreak will be warmer than an unprotected area. These local variations must be considered in deciding the location of a planting or the time of planting.

Table 2 gives approximate first seeding or planting dates for common vegetable crops. Dates are given for Zones A, C and E. Planting dates for the other zones fall between these dates. These dates are a guide for seeding but seasons will have to be taken into consideration. If long-term weather predictions are available they are helpful in deciding whether to seed earlier or later than the dates given. With many crops the soil temperature is very important in determining the rate of early growth. For this reason, even if air temperatures are high, if the soil has not yet warmed up, planting should be delayed somewhat.

TABLE 2. FIRST FIELD SEEDING OR PLANTING DATES FOR COMMERCIAL PRODUCTION

Crops	**Zone A**	**Zone C**	**Zone E**
FROST-HARDY Asparagus, broccoli, Brussels sprouts, cabbage, lettuce, onions (set, seed and Spanish) radish, rhubarb, pea, spinach, parsnip, early potato	April 1-15	April 15-25	April 25-May 10
SEMI-FROST-HARDY Beet, carrot, cauliflower, celery, late potato, early sweet corn	April 15-25	April 25-May 10	May 5-15
SEMI-FROST-TENDER Snap bean, sweet corn, tomato	May 1-15	May 15-25	May 25-June 5
FROST-TENDER Lima bean, cucumber, eggplant, muskmelon, pepper, pumpkin, squash, watermelon	May 20-30	May 25-June 5	June 5-15

BEFORE USING
ANY PESTICIDE

STOP

READ
THE
LABEL

SEEDS

APPROXIMATE PLANTING DEPTH AND NUMBER PER GRAM

Crop	Seeds per gram	Seed Planting Depth in mm
Asparagus	50	25
Bean, snap	2-3	40
Bean, lima	1-3	40
Beet, Swiss Chard	50	15
Broccoli	320	5
Brussels sprouts	280	5
Cabbage	300	5
Chinese Cabbage	250	5
Carrot	900	5
Cauliflower	350	5
Celery, Celeriac	1,800	3
Chicory	600	5
Collard	280	5
Corn	4-8	40
Cucumber	40	20
Eggplant	200	15
Endive	550	5
Kale	270	5
Kohlrabi	280	5
Leek	350	15
Lettuce	700	5
Melon	40	25
Mustard	550	5
Onion	280	15
Parsley	550	5
Parsnip	200	15
Pea	3-6	25
Pepper	150	5
Pumpkin	4	25
Radish	125	15
Rutabaga	280	5
Spinach	90	20
Squash	10	25
Tomato	350	5
Watermelon	10	25

NUMBER OF PLANTS PER HECTARE AT VARIOUS PLANTING DISTANCES

Row Spacing in cm	Distance in the row in cm						
	10	15	30	45	60	75	90
30	332,780	215,190	107,590	71,730	53,780	43,030	35,860
45	215,190	143,460	71,730	47,820	35,860	28,700	23,910
60	161,390	107,590	53,800	35,860	26,900	21,510	17,930
75	129,110	86,080	43,030	28,700	21,510	17,220	14,350
90	107,590	71,980	35,860	23,910	17,930	14,350	12,300
110	92,230	61,480	30,750	20,500	15,360	12,300	10,250
120	80,690	53,800	26,900	17,900	13,460	10,770	8,790

PLANT POPULATION AND PRECISION SEEDING

The use of herbicides, fertilizers, and, to some extent, irrigation, has drastically changed the way vegetable crops can and should be grown. Most crops can be grown much closer than the old conventional spacings, which were approximately the width of a horse-drawn cultivator. Much closer spacing allows more crop on the same unit of land. Each crop should be spaced according to its optimum needs. Seeding carrots 2 to 4 cm apart in all directions eliminates most stress factors, resulting in uniform carrots free from disease and misshapen roots. More than 8 to 12 rows of carrots per bed, at 4 x 4-cm spacing, will interfere with light penetration of the foliage cover and adversely affect yield. Lettuce seeded in beds and spaced 30 cm between plants produces more heads per unit of land, as well as a much higher percentage of marketable heads. Onions sown in double rows 5 to 8 cm apart in and between the double rows, 4 to 6 double rows per bed, not only produce larger onions but much higher yields. The same can be said for many other crops. As plants reach the optimum spacing for their particular needs, growth improves and yields increase.

To obtain the optimum plant density, a system of precision seeding is needed. This system starts with the preparation of a fine, smooth seedbed, followed by uniform seeding at the same depth, at exact in-row and between-row spacings. See crop sections for spacing requirements.

With precision seeding the harvested product will be more uniform in size and shape. Less effort will be required in grading and packing, and fewer culls will be obtained.

However, to achieve complete success with precision seeding, all factors — seed sizing, seed coating, high germination, uniform bed characteristics, and uniform seeding depth — must be included. By omitting just one factor, the results may be no better than with more conventional seeding methods.

The distance between rows will be determined by the method used to harvest the crop. Solid-bed planting can be done with some crops.

A precision seeder delivers the seed exactly where the final plant for harvest is to be grown. If this is accomplished, and the seed germinates normally, no thinning or transplanting will be required. The 'ifs' are the quality of the seed and the uniformity of the seedbed.

Another important factor to consider is the kind of seed coat. Rough or angular seed like carrot and lettuce must be coated to a smooth, uniform shape with a water-absorbing material. Onions need to be coated to be successfully precision seeded. Seeds that are naturally smooth and round, such as cabbage, cauliflower, radish and rutabaga, need only to be separated to exactly the same sizes to provide uniform growth in the field. Results with precision-seeding research in Ontario to date indicate that higher yields of better quality vegetables are possible, regardless of when the crops may be grown.

Pre-germinated seed of most species will ensure more rapid emergence and may gain time for emergence over the slower non-germinated seed. This can assist the seed to emerge before soil crusts form or weed seeds emerge.

WEED CONTROL

For chemical weed-control recommendations refer to OMAF Publication 75, *1986 Guide to Chemical Weed Control.* It contains much more complete information than was formerly included in this publication (No. 363), including detailed information on the various herbicides, safety precautions, care and calibration of sprayers, etc.

Herbicides should not be used in greenhouses and other plant-growing structures unless specifically recommended.

Chemical weed control should never be a substitute for good cultural practices. Reduce the spread or increase of weed seeds by cutting or disking weeds before they go to seed. Concentrate on the eradication of persistent perennial weeds by cultural practices. Thorough working of the land prior to seeding or planting will kill many small weeds that have just germinated. Careful shallow cultivation is best. The modern grower should use chemical weed killers wherever practical as a supplement to good cultural practices.

It is very important to apply the correct dosage when using these chemicals. Herbicides can cause severe injury to the crop if more than the recommended rate is used. **Do not experiment with chemicals or mixtures which are not recommended.** If more than a permitted amount of herbicide residue is found in the crop, the entire crop can be seized without compensation to the grower.

CAUTION!

Spray drift can damage or destroy susceptible crops and shrubs for a great distance from the sprayer. Do not use 2,4-D-type herbicides near susceptible crops such as grapes, beans, tomatoes, or tobacco. Take into consideration both the direction and speed of the wind when applying this type of herbicide. Use low pressure whenever possible (200 to 250 kPa is usually enough). **Do not use the same sprayer for applying 2,4-D and similar herbicides as you use for spraying insecticides and fungicides.** Drain and wash out the sprayer immediately after use. **Do not mix different herbicides, or herbicides with other pesticides, foliar fertilizers, surfactants, or detergents unless recommended by competent authorities.**

SOIL MANAGEMENT AND FERTILIZER USE

SOIL CLASSIFICATION AND TYPE

A well drained, sandy soil is of value for early vegetable crops. Sandy loam and silt loam soils are valuable for the production of most vegetable crops. Muck land is ideal for some salad and root crops. Clay loam and clay soils are used for certain processing crops. Proper fertilization, drainage, irrigation, and cultivation practices are essential on all soils and will extend the range of soils which may be successfully used for vegetable production.

Detailed soil maps of some counties are available from the Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5. These maps give a very good indication of the soil type in your area, but on-the-site examination will also be necessary.

Soils which are well drained and provide a good depth of permeable rooting volume are necessary. Impervious layers or a high water table can reduce the penetration of roots by excluding oxygen. Excessive moisture can be removed by tile drainage.

SUBSIDENCE OF PEAT AND MUCK SOILS

Cultivated **peat** and **muck** soils decompose (oxidize) and thus subside gradually at rates of 1 to 3 cm/year. Maintaining a high water table and a low pH reduce the rate of subsidence to less than 0.5 cm per year. See OMAF Factsheet 512, *Management of Organic Soils* for more detailed information on water control and recommended heights of water table for vegetable crops. However, a very wet (or very acidic) soil does not give maximum yields, and is likely to be flooded when rainfall is intense. Wet spots may also be difficult to work and result in uneven crop growth. Recent research has shown that copper (Cu) applied as fertilizer has the residual effect of slowing down degradation, and thus subsidence by about 50%. It is recommended that 14 kg of Cu/ha be applied annually to **peats** and **mucks** in the first 3 years of cultivation and up to 5 kg of Cu/ha added every second or third year thereafter, particularly when onions, carrots or lettuce are grown on these soils.

ORGANIC MATTER AND CROP ROTATION

Soil organic matter breaks down very rapidly with the intensive cultivation used on vegetable land, especially where irrigation is practiced. While rotations including sod crops are most effective in maintaining organic matter, it may be necessary to rely on green-manure and cover crops where rotations are not feasible. Organic soils, such as peats and mucks, do not require these special practices to maintain organic matter.

Grasses or legumes should appear in the rotation at least once every three years, or better, twice every four years. These crops are important in the rotation since they maintain porosity and good structure in fine-textured soils. They improve the water-holding capacity of sand and sandy loams. In addition to maintaining good soil structure, the organic matter helps to control several common soil-borne vegetable diseases.

GREEN-MANURE AND COVER CROPS

The benefit from these soil-improving crops will be greatest on a soil which is adequately fertilized. As a general rule, apply 30 to 40 kg N/ha with as much phosphate and potash as the crop requires based on soil tests, to the soil at or before seeding. The recovery of nitrogen applied will amount to about 30% for the first vegetable crop.

The following are suggested as fall-seeded cover crops. The seeding rate is minimum.

1. Winter rye at 1.80 kg/ha.
2. Domestic or Italian rye grass at 22 kg/ha.
3. Spring wheat or oats at 130 kg/ha where potatoes or a small-seeded vegetable crop is planned. These crops will hold the soil, but will be killed by frost and will not cause any difficulty in seeding the next spring. Winter rye, with heavy straw growth, makes seeding difficult.

The following green-manure crops are suggested for spring seeding.

1. Soybeans at 130 kg/ha inoculated with a suitable culture and treated with a combination fungicide-insecticide seed protectant.
2. Sudan grass at 35 kg/ha where irrigation is available or soil moisture is abundant.
3. A mixture of peas at 65 kg/ha plus oats at 100 kg/ha sown as early as possible in the spring before a late-planted crop.
4. Sweet clover at 12 to 22 kg/ha or a mixture of sweet clover at 12 kg/ha plus red clover at 6 kg/ha where a soil is taken out of cultivation for one year to improve soil structure.

MANURE

Manure is a good source of organic matter and plant nutrients. Whenever available, it should be used.

For maximum conservation of plant nutrients, manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Manure is used more effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates supplying more nitrogen than the crop requires.

Avoid application of liquid manure to crop foliage as it can damage the crop.

For most effective use of the nitrogen in manure, it should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure is one way of preventing nitrogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However, phosphate applied after a crop is seeded may not be available to that crop. Phosphate fertilizer requirements should therefore not be adjusted for manure applied after seeding.

If manured soil is plowed in late summer or early fall, a cover crop should be seeded. Manure containing much undecomposed straw or shavings should not be applied in the spring when potatoes are to be grown, as it may promote scab development.

The fertilizer requirements given for each crop in this publication do not contain any adjustment for applications of manure. If manure is applied, the amount of fertilizer to be deducted from the crop requirements is indicated in the accompanying table for each type of manure.

These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure), 40% of the phosphate and 90% of the potash

REDUCTIONS IN FERTILIZER APPLICATION WHERE MANURE IS APPLIED IN THE SAME CROP YEAR*

Class of Livestock	Nitrogen (kg/ha) F. & W.**	Nitrogen (kg/ha) Spr.**	Nitrogen (kg/ha) Spr. C.**	Phosphate P_2O_5 (kg/ha)	Potash K_2O (kg/ha)
Liquid Manure at 10 cubic metres/hectare (One cubic metre = 220 imp. gal; one cubic metre/ha = 90 gal/ac)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes/hectare (66 bu. or 2.40 cubic metres of solid manure = 1 metric tonne approximately. Ten t/ha = 4.5 ton/ac.)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

* *These adjustments are based on slightly below average-quality manure.*

****F. & W.** *denotes fall and winter-applied manure;* **Spr.** *denotes spring applied and not covered immediately, including surface application after seeding;* **Spr. C.** *denotes spring-applied manure injected or otherwise covered within one day of application.*

are as available in the year of application as the nutrients in manufactured fertilizer.

Where the manure is applied in the fall, more nitrogen is lost (to the air and by leaching) than when spring applied. The nitrogen adjustments should be 50% lower for fall-applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applications. Do not spread manure in winter or early spring on field that are subject to runoff.

LONG-TERM VALUE OF MANURE

The long-term availability of phosphorus, potassium and magnesium in manure is best measured by soil tests. Some of the nitrogen in cattle and swine manure also continues to become available for plant growth and affects the nitrogen fertilizer requirements in the years after application. Adjustments for residual nitrogen in manure are presented in the accompanying table.

These adjustments apply while manure continues to be used and for the first year after manure application ceases. In addition to adjustments for the residual long-term value, the normal short-term adjustment in nitrogen requirement should also be made for manure applied in the year the crop is grown. (See table above).

No adjustment should be made for the long-term effects of poultry manure because most of the available nitrogen it contains is released in the year of application.

MANURE ANALYSIS

The nutrient content of manure varies not only with the type of livestock but with their age, the ration fed, the type of bedding or amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publication the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis service is offered by the Department of Land Resource Science, University of Guelph and various private laboratories. Samples are analyzed on a cash-with-sample basis. Containers for shipping manure and further information are available from district or county offices of the Ontario Ministry of Agriculture and Food.

ADJUSTMENT OF NITROGEN REQUIREMENT FOR THE VALUE OF CATTLE OR SWINE MANURE APPLIED IN PREVIOUS YEARS

Rate of Manure Application		Years of Manure Application	Consecutive Reduction in Crop Nitrogen Requirement kg N/ha
Solid (t/ha*)	Liquid (cubic m/ha*)		
20	50	5	20
20	50	10	30
40	100	3	20
40	100	5	30
40	100	10	30

* *66 bu manure = 1 metric tonne approximately. 10 tonne/ha = 4.5 tons/ac. One metre^3 = 220 Imperial gallons. One metre^3/ha = 90 gal/ac.*

SOIL TESTING

Before planting any crop get a soil test. Soil tests give you information on the nutrient elements available in soil but cannot tell the suitability of a soil for a specific crop.

The soil test can:

1. indicate the kind and amount of lime required;
2. measure the soil nutrients available for crop production;
3. provide the basis for suggested rates for fertilizer applications.

Soil testing is currently by far the most accurate tool available in Ontario to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to crops.

ALTERNATIVES TO THE SOIL TEST

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.
2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.
3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen as, with some crops, we do apply close to what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last for many years, and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser-textured soils.

ANALYSES AVAILABLE THROUGH THE OMAF SOIL TESTING SERVICE AT AGRI-FOOD LABORATORIES, 503 IMPERIAL ROAD, UNIT 1, GUELPH, ONTARIO N1H 6T9

MATERIALS	WHAT IS ANALYZED	COST PER SAMPLE*
1. Field Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement; Calcium (on tobacco soils only)	No Charge
2. Home Garden and Lawn Soils	Plant-available Phosphorus Potassium, Magnesium; pH; Lime requirement	$1.00
3. Commercial Turf Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement	No Charge
4. Greenhouse Media, Water** and Nutrient Solutions**	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Sulfates; Chlorides; Total Salts	No Charge
5. All Soils (optional, on request only)	Plant-available Manganese and Zinc	$2.00
6. All Soils (optional, on request only)	Organic Matter	$5.00

* *Prices effective September 1, 1984.*

***Laboratory requires 500 mL sample.*

To determine your fertilizer requirements for a specific crop on a specific field, the soil testing program is the main guide, with some help from plant analysis and nutrient deficiency symptoms.

WHAT DOES THE OMAF SOIL TESTING PROGRAM PROVIDE FOR THE FARMER?

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum yields under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done: (a) for maintenance (to maintain high soil-nutrient levels); and, (b) to allow for some error in sampling the field.

No soil test is available which is satisfactory for nitrogen under Ontario conditions. The nitrogen recommendations for different crops on mineral and muck soils are compilations from all of the research experience in Ontario.

The phosphate and potash requirements for different crops are presented on pages 21 and 22. These recommendations and the soil tests on which they are based are approved by the Ontario Soil Management Research Committee.

Where a recent soil test is not available, a rough estimate of fertilizer requirements can be obtained from the tables on pages 21 and 22, using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the **medium** soil-test rating;

b. If the field has received little fertilizer in the past, use one of the rates recommended for the **low** soil-test rating. Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

MICRONUTRIENT TESTS

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper or iron. Tests for these elements range from rather unreliable in the case of boron to useless in the case of copper on Ontario soils. Plant analysis and visual symptoms are useful for determining boron and copper needs.

SOIL TESTS FROM OTHER LABORATORIES

Each year a number of growers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory uses the identical chemical tests used in the OMAF laboratory and expresses their test results in the same units, the OMAF fertilizer requirements for phosphorus and potash can be applied. However, it is rare that this is the case.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations leads to less reliable recommendations than are now provided.

SOIL SAMPLING

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field, should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken, the more likely the soil sample will provide a reliable measure of the fertility in the field. The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well, and a full soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ in appearance of soil or crop, or in previous fertilization, manuring or liming should be sampled separately if they are large enough to fertilize separately. It can be quite informative to sample problem areas separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

WHEN TO SAMPLE

Each field should be sampled once every two to three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example, with crops such as potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the grower, with a copy to the county or district office of the Ontario Ministry of Agriculture and Food, within five working days of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring-seeded crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample.

SAMPLE BOXES AND INFORMATION SHEETS

Soil sample boxes and information sheets may be obtained from any district or county office of the Ontario Ministry of Agriculture and Food or from Agri-Food Laboratories, Unit 1, 503 Imperial Road, Guelph, Ontario N1H 6T9.

Management practices which affect a soil test recommendation are: manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

CHANGES IN CROP OR MANAGEMENT

Fertilizer requirements on the OMAF soil test report are for specific crops and management. If the crop management is changed in regard to legumes plowed down or manure applied, the adjustments in fertilizer requirements may be made using the manure and legume-sod adjustments in the table above and on page 14. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in this publication.

NITROGEN ADJUSTMENT FOR LEGUMES PLOWED DOWN

When sod containing legumes such as alfalfa, trefoil and clover is plowed under, it supplies an appreciable amount of nitrogen to the following crop. The table above shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

ADJUSTMENT OF NITROGEN REQUIREMENT WHERE SOD CONTAINING LEGUMES IS PLOWED DOWN

Type of Sod	For all Crops Deduct from N Requirement kg N/ha
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	110
Perennial legumes seeded and plowed the same year	20

PLANT ANALYSIS

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the "normal" and "critical" values for the crop can indicate whether nutrient supply is adequate for optimum growth.

Plant analysis is a useful supplement to soil testing for evaluation of the fertility status of crops. It is quite independent of soil testing and can provide a valuable "second opinion", especially for phosphorus, potassium, magnesium and manganese. For nitrogen and zinc it has not been very reliable. For boron and copper we don't have a reliable soil test, so plant analysis and visual symptoms are the only methods for diagnosing deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not always indicate the cause of a deficiency or the amount of fertilizer required to correct it.

SAMPLING

Time of sampling has a major effect on the results since nutrient levels within a plant vary considerably with the age of the plant. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, plants suspected of being nutrient deficient should be sampled as soon as a problem appears. Samples are best taken from a problem area rather than from the entire field.

Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Each sample should consist of at least 30 grams of fresh material. Problem areas should be sampled separately. When taking samples for plant analysis take care not to contaminate the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.

SAMPLE PREPARATION

Samples of fresh plant material should be delivered directly to the laboratory. If they are not delivered immediately they should be dried to prevent spoilage. Samples may be dried in an oven at 65°C or less, or dried in the sun provided precautions are taken to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc-coated) metal, brass or copper.

Plant analyses may be obtained from several laboratories in Ontario.

SEWAGE SLUDGE

Land may not be used to grow vegetables within six months after sludge applications. This avoids the potential hazards associated with the presence of pathogens and, in particular, of parasitic organisms.

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most vegetable crops grow well in a soil pH range from 6.0 to 7.5 on mineral soils and from 5.0 to 6.0 on muck soils. Many vegetable crops grow well on mineral soils above pH 7.5 but micronutrient deficiencies are more likely.

To correct soil acidity ground limestone should be broadcast and worked into the soil at rates determined by soil test. The accompanying table shows the soil pH values below which lime is recommended and the "target" soil pH to which soils should be limed for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

THE BUFFER pH

Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH), use the Lime Requirement table to determine the amount of lime required to reach different "target" soil pH values required for different crops.

SOIL pH AT WHICH LIME IS RECOMMENDED FOR ONTARIO CROPS

Crops	Soil pH Below Which Lime is Recommended	Target Soil pH*
Coarse and Medium-Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All crops not listed below	6.1	6.5
Corn, soybeans, winter rye, grass hay and pasture, turf, tobacco	5.6	6.0
Potatoes	5.1	5.5
Fine-Textured Mineral Soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
All crops not listed above or below	5.6	6.0
Corn, rye, grass hay and pasture, tobacco	5.1	5.5
Organic Soils (peats and mucks)		
All field and vegetable crops	5.1	5.5

**Where a crop is grown in rotation with other crops requiring a high pH (for example, corn in rotation with wheat or alfalfa) it is recommended that the soil be limed to the higher pH.*

LIME REQUIREMENTS TO CORRECT SOIL ACIDITY BASED ON SOIL pH AND SOIL BUFFER pH

Buffer pH	Target Soil pH = 6.5 Lime if soil pH below 6.1	Target Soil pH = 6.0 Lime if soil pH below 5.6	Target Soil pH = 5.5 Lime if soil pH below 5.1
	Ground limestone required — t/ha (Based on an Agricultural Index of 75)		
7.0	2	0	0
6.9	2	0	0
6.8	2	0	0
6.7	2	2	0
6.6	3	2	0
6.5	3	2	0
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	9	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

EXAMPLE CALCULATION OF THE FINENESS RATING OF A LIMESTONE

Particle Size	% of sample		Effectiveness factor		
Coarser than No. 10 sieve*	10	x	0.0	=	0
No. 10 to No. 60 sieve	40	x	0.4	=	16
Passing through No. 60 sieve	50	x	1.0	=	50
			Fineness Rating	=	66

**A No. 10 sieve has wires spaced 2.0 mm, and a No. 60 sieve spaced 0.25 mm apart.*

LIMESTONE QUALITY

Calcitic limestone consists largely of calcium carbonate. Dolomitic limestone is a mixture of calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less as it is an excellent inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Two main factors affect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone, and hence it neutralizes acidity much more slowly — so slowly that it is of little value.

The calculation of a fineness rating for ground limestone is illustrated in the accompanying table.

THE AGRICULTURAL INDEX

Some means of combining the Neutralizing Value and the Fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index".

$$\text{The agricultural index} = \frac{\text{neutralizing value x fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity[1]. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the Ontario soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\begin{array}{c}\text{Limestone}\\ \text{application}\\ \text{rate from soil}\\ \text{test report}\end{array} \times \frac{75}{\begin{array}{c}\text{Agri. Index}\\ \text{of your limestone}\end{array}} = \begin{array}{c}\text{Rate of}\\ \text{application}\\ \text{of your limestone}\end{array}$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 9 x 75/90 = 7.5 t/ha.

TILLAGE DEPTH

Lime recommendations presented here should raise the pH of the top 15 cm (6 inches) of a soil to the listed target pH. If the soil is ploughed to a greater depth than 15 cm, proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils it should be incorporated to 15 cm depth where practical.

LOWERING SOIL pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate. If the soil pH is above 7.0 it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

FERTILIZER ANALYSES AND BLENDS

The Ontario Soil Management Research Committee recommends fertilizers on the basis of the nutrient requirements shown by research, and soil tests. In some situations traditional fertilizer ratios will meet the combined requirements for nitrogen, phosphate and potash. Most fertilizer dealers can produce blends which meet the needs of the crop, as indicated by soil tests.

FERTILIZER MATERIALS

Nitrogen fertilizers are available in dry, liquid and gaseous forms. Which of these forms to use is a matter of choice for the individual vegetable grower, depending upon availability of the material, equipment for handling, cost per kilogram of nitrogen, the cost of application and grower preference.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen, not kilograms of materials, are used. The table on page 19 shows the percentage fertilizer nutrient contained in different materials.

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[1] *The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.*

NUTRIENTS IN FERTILIZER MATERIALS

Nitrogen Materials	Form	% Nitrogen (N)*
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid**	20
Ammonium nitrate-urea (UAN)	Liquid	28
Ammonium nitrate-urea (UAN)	Liquid	32
Ammonia-ammonium nitrate-urea	Liquid**	41
Ammonia-ammonium nitrate	Liquid**	41
Anhydrous ammonia	Liquid**	82
Phosphate Materials	**% Phosphate (P_2O_5)***	
Superphosphate	18 to 20	
Triple superphosphate	44 to 46	
Monoammonium phosphate (MAP)	48 to 52	
Diammonium phosphate (DAP) 18-46-0	46	
Potash Materials	**% Potash (K_2O)***	
Muriate of potash	60	
Sulfate of potash	50	
Sulfate of potash-magnesia (11% Mg)	22	
Potassium nitrate (13-0-44)	44	

* *Kilograms of N, P_2O_5 or K_2O supplied in 100 kilograms of material.*

***Liquid under pressure.*

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient; (2) differences in solubility of the salts in the soil; and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia or boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in the soil solution at any one time is very low.

1. **Nitrogen Fertilizers**

   Ammonium nitrate, monoammonium phosphate and ammonium sulfate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea.

   Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

   Anhydrous ammonia and aqua ammonia are extremely toxic fertilizers and should not be applied near seeds unless applied at least one week before seeding. Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

2. **Phosphate Fertilizers**

   Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of vegetable crops.

   Diammonium phosphate is more toxic than other phosphate fertilizers — see above under nitrogen fertilizers.

3. **Potash Fertilizers**

   Muriate of potash (KC1) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

   Sulfate of potash (K_2SO_4) is less toxic than muriate of potash.

   Sulfate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

   Potassium nitrate is one of the safer sources of potassium when considered as a nitrogen source as well.

4. **Fertilizers Containing Micronutrients**

   Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients, and maximum safe rates should be reduced. Boron is particularly toxic.

FERTILIZER PLACEMENT

Phosphorus is most important for early growth and is more available if placed near the seed. For transplant crops, the use of high-phosphorus starter solution is a profitable practice.

Nitrogen fertilizers readily dissolve in the soil water and move easily through the soil to the plant roots. Placement of nitrogen is less important than for phosphorus. Part of the nitrogen requirements is usually broadcast, injected or worked into the soil before planting, often to hasten the breakdown of the cover crop. Much of the nitrogen is not applied until side-dressing in order to conserve the fertilizer from leaching or to restrain plants from too much vegetative growth.

Too much potassium applied in a band at planting or in the transplant water can injure young seedlings and reduce crop yield and quality. This danger of fertilizer injury is greater on sands and sandy loams than on silt loam and clay loam soils. On the coarse-textured sands and sandy loams part of the potassium fertilizer requirements should be broadcast and worked into the soil before planting.

STARTER SOLUTIONS

Water-soluble fertilizers (e.g. 10-52-10) and liquid fertilizers (e.g. 6-24-6 and 10-34-0) are used as starter solutions at planting time to stimulate the growth of young transplants.

Vegetable crops will benefit if starter solutions are used when the young transplants are set in the field.

SIDE-DRESSING

The purpose of side-dressing is to supply additional nutrients during growth of the crop. Most commonly, nitrogen is the nutrient that is supplied after the plant has reached a certain stage of development. With crops that produce fruit (e.g. peppers or tomatoes) it is important not to have too much vegetative growth early in the season, or flowers will not develop, or may drop off if they do develop. For this reason, it is usually advisable to put only a moderate amount of nitrogen in the soil at the time of seeding or planting. After the plant has set some fruit and is no longer in danger of becoming too vegetative, extra nitrogen can be applied. The timing and amount of nitrogen side-dressing must be judged from the appearance of the plants. On coarse, sandy soil it may be advisable to add potash as well as nitrogen.

FERTILIZER THROUGH THE IRRIGATION SYSTEM

Many fertilizers, but particularly nitrogen, may be applied through the irrigation system during the growing season. In some crops it is difficult to move along the rows with machinery without damaging the plants, whereas the irrigation water will penetrate fairly evenly over the whole area without damaging the plants. Additional information is given on page 23 under Irrigation.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is 6.0 or lower, the most effective means of supplying magnesium is by application of dolomitic limestone. If the pH is above 6.0, magnesium can be supplied by either magnesium sulfate or sulfate of potash-magnesia. These latter sources of magnesium are usually quite expensive.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low-magnesium soils.

A magnesium deficiency may occur on carrots, celery, tomatoes and spinach. The usual symptom is yellowing of the older leaves while the veins remain dark green. Magnesium deficiency in celery may be caused by a genetic abnormality in which the plant is unable to obtain magnesium from the soil. Potato plants become lighter in color.

MICRONUTRIENTS

Micronutrient elements should not be combined with insecticide or fungicide sprays unless the manufacturer's directions indicate that this may be done or experience has shown they are compatible.

Micronutrient elements should be applied only on competent advice or where experience has proven their application to be necessary. Soil or foliar applications can be made. Soil applications are generally made at soil-preparation time and foliar applications are applied during the growing season. A sticker-spreader should be included in micronutrient sprays.

Boron. A lack of boron causes a breakdown of the young tissue with slow growth, tissue cracking, blackening, and misshapen plants. In addition, the leaves of beets and spinach become twisted with light spots on the petioles. Internal breakdown (internal black spot) may occur in the roots or may appear on the root surface as external cankers. Broccoli and cauliflower show leaf rolling and deformed buds, hollow stems, and the heads turn brown. Cabbage develops internal dead spots and hollow stems. Corn kernels fail to develop at the tip of the cob and the ears are barren. Celery petioles show reddish brown spots (cat-scratches). Rutabagas develop water-soaked areas (water-core) internally.

Because boron is needed only in very small quantities, and since an overdose is toxic, extreme care should be taken in its use. Continued applications should be made only on expert advice. Application of boron to mineral soils has not been universally successful; foliar sprays have generally given faster and more effective results. Spray when the young plants are about 8 cm high. A second application may be required. On request, boron fertilizers may be mixed with ordinary fertilizers by manufacturers.

Copper. Copper-deficient lettuce leaves lose their firmness (rabbit-ear), become chlorotic, and the plants become bleached on the stems and leaf margins. Onions produce thin pale-yellow scales which cause poor color and keeping quality. A lack of copper also causes poor color in carrots.

Copper deficiency seldom occurs in mineral soils of Ontario; however, copper sulfate should be used for at least three years on new muck soils. Further applications should be made as suggested by experience and experimental evidence.

Soil-applied fertilizer copper has recently been shown to have the residual effect of slowing down the undesirably rapid degradation and subsidence of cultivated muck soils (see page 13).

Extreme care is necessary using foliar sprays with copper sulfate, because injury to the foliage may occur readily. Competent advice in the use of copper sprays is necessary.

Manganese. The general symptoms of manganese deficiency are interveinal chlorosis of leaves which begins in the younger foliage. Later the whole plant may be affected. A russeting, curling and dwarfing of the foliage occurs in beets. Other crops susceptible to manganese deficiency are beans, carrots, onions, celery, and tomatoes. Spray applications have proven more effective than soil applications. Apply sprays when the plants are about one-third grown, or sooner if this deficiency is identified. Two or more sprays may be necessary at 10-day intervals to correct the deficiency.

Molybdenum. Deficiency symptoms on cauliflower and broccoli start with cupping of the leaf margins and interveinal chlorosis of the younger leaves. As the leaves develop, twisting of the midrib and irregular development of the leaf tissue cause a strap- or whip-like appearance (whiptail). The early symptoms of molybdenum deficiency in other crops are similar to nitrogen deficiency. Later symptoms are interveinal mottling of leaves with chlorotic areas becoming puffy, marginal cupping and scorching of leaves, twisting and distortion of younger leaves.

This deficiency occurs more on sandy, acid soils; however, it may occur even in neutral soils if soil-molybdenum reserves are depleted by heavy cropping. Molybdenum availability to plants increases with an increase in pH, and differs from the other trace elements. Consequently, liming acid soil may be a good practice to overcome molybdenum deficiency. Molybdenum can also be applied in the transplanting water at the rate of 30 to 40 g of sodium molybdate per 100 L of water, each plant receiving 0.3 L of this solution.

SECONDARY AND MICRONUTRIENT RECOMMENDATIONS

The following secondary and micronutrients are the only ones which have given major problems in Ontario. To prevent foliar sprays from being toxic to the plant, do not exceed the recommended concentration. The spray should be sufficient to wet the foliage.

Nutrient	Application Rate Soil* kg of nutrient/ha	 Foliar kg of nutrient/ 1000 L water	Common Sources	
Calcium (Ca)**	—	2.2-4.0	Calcium chloride	36% Ca
	—	1.2-3.4	Calcium nitrate	19% Ca
Magnesium (Mg)	27.5-33.0	—	Dolomitic limestone	6-13% Mg
	27.5-33.0	—	Epsom Salts (magnesium sulfate)	9.6% Mg
	17.0-22.5	—	Sulfate of potash-magnesia	11% Mg
Boron (B)	1.0-3.0	0.2-0.6	Various sources are available	8-21% B
Copper (Cu)	7.0-14.5	0.5-1.5	Copper sulfate	13-25% Cu
			Copper chelates	9-13% Cu
			Copper oxide	60-80% Cu
Manganese (Mn)	—	0.5-1.0***	Manganese sulfate	26-28% Mn
			Manganese chelates	9-12% Mn
Molybdenum (Mo)	—	0.1-0.25	Sodium molybdate	39% Mo
Zinc (Zn)	4.0-12.0	0.6	Zinc sulfate	36% Zn
	1.0-2.0		Zinc chelates	9-14% Zn
	4.0-12.0		Zinc oxide	78-80% Zn

* *Double rates for muck soil*

** *For blackheart of celery*

****For onions — use 1.5-2.75 kg/1000 L*

PHOSPHORUS REQUIREMENTS — VEGETABLES ON *MINERAL* SOILS — PHOSPHATE (P_2O_5) REQUIRED — kg/ha

Phosphorus Soil Test ppm P in soil	Rating	Beans (lima) Beans (snap) Peas	Radish	Sweet Corn Established Asparagus	Beet Carrot Lettuce Onion Parsnip Rutabaga Spinach	Potato	Cucumber Muskmelon Pumpkin Squash Tomato* Watermelon	Celery Rhubarb	Broccoli** Brussels sprouts* Cabbage* Cauliflower* Eggplant* Pepper* Asparagus (nursery and new plantings)
0-3	LOW	80	80	110	180	200	230	230	270
4-5		60	70	100	170	200	230	230	260
6-7		50	60	90	170	190	220	220	250
8-9		40	60	70	160	190	220	220	240
10-12	MEDIUM	30	50	50	160	180	210	220	230
13-15		20	50	20	150	170	190	210	220
16-20	HIGH	0	40	20	140	160	170	190	200
21-25		0	40	0	120	140	140	160	170
26-30	VERY HIGH	0	30	0	100	120	110	140	140
31-40		0	30	0	80	90	80	110	110
41-50		0	20	0	50	50	50	80	80
51-60		0	0	0	30	30	30	50	50
61-80	EXCESSIVE	0	0	0	0	[illegible]	0	0	0
80+		0	0	0	0	30	0	0	0

* *For transplanted tomatoes, peppers and eggplants apply a starter solution, such as 1 L of 10-34-0 per 100 L water, or 1 L of 6-24-6 per 75 L at planting.*

For transplanted broccoli, Brussels sprouts, cabbage and cauliflower, if no insecticide is used in the planting water apply a starter solution high in nitrogen such as 20-20-20 at 1 kg/200 L. Under high temperatures and in dry sandy soils use half the concentration of fertilizer.

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

POTASSIUM REQUIREMENTS — VEGETABLES ON *MINERAL* SOILS — POTASH (K_2O) REQUIRED — kg/ha

Potassium Soil Test ppm K in soil	Rating	Radish	Beans (lima) Beans (snap) Peas	Sweet corn	Cucumber Muskmelon Pumpkin Squash Watermelon	Beet Carrot Lettuce Onion Parsnip Potato *Spinach*	Broccoli Brussels sprouts Cabbage Cauliflower Eggplant *Pepper*	Celery Rhubarb Rutabaga*	All Asparagus	All Tomatoes*
0-15	LOW	60	120	170	230	230	270	340	420	660
16-30		60	110	160	220	220	250	330	400	640
31-45		50	90	140	200	210	230	310	360	600
46-60		50	80	110	180	190	200	280	320	560
61-80	MEDIUM	40	60	60	140	160	170	250	280	480
81-100		30	40	40	100	130	130	200	250	400
101-120		30	30	30	70	100	100	150	220	340
121-150		20	0	0	50	80	80	90	190	300
151-180		20	0	0	40	50	50	50	160	280
181-210	HIGH	0	0	0	0	0	0	0	130	140
211-250	VERY HIGH	0	0	0	0	0	0	0	80	70
250+	EXCESSIVE	0	0	0	0	0	0	0	0	0

**For rutabagas and tomatoes on soils with magnesium tests less than 100, the required amount of potash is adjusted downward from the amounts shown in this table to a minimum of 50% at 50 ppm Mg.*

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

PHOSPHORUS AND POTASSIUM REQUIREMENTS — VEGETABLES ON *MUCK* SOILS

Phosphorus Soil Test ppm P in soil	Rating	Beet, Broccoli, Brussels sprouts, Cabbage, Carrot, Cauliflower, Lettuce, Onion*, Parsnip, Potato, Radish, Spinach Phosphate (P_2O_5) required kg/ha	Celery Phosphate (P_2O_5) required kg/ha
0-3	LOW	100	120
4-5		100	120
6-7		100	120
8-9		100	120
10-12	MEDIUM	90	120
13-15		90	110
16-20		80	100
21-25		70	90
26-30		60	80
31-40	HIGH	50	70
41-50		30	50
51-60	VERY HIGH	20	40
61-80	EXCESSIVE	0	0
80+		0	0

Potassium Soil Test ppm K in soil	Rating	Broccoli Brussels sprouts Cabbage Cauliflower Potash (K_2O) required — kg/ha	Carrot Celery Onion Parsnip Potato Potash (K_2O) required — kg/ha	Beet Lettuce Radish Spinach Potash (K_2O) required — kg/ha
0-15	LOW	200	230	100
16-30		190	220	100
31-45		170	210	90
46-60		150	200	80
61-80	MEDIUM	120	170	60
80-100		90	150	40
101-120		70	120	30
121-150		50	80	20
151-180		40	40	20
181-210	HIGH	0	0	0
211-250	VERY HIGH	0	0	0
250+	EXCESSIVE	0	0	0

* *If maturity of onions is a problem on organic soils less than 40 cm deep, additional phosphate may be required.*

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

GROWTH REGULATORS

Chemical growth regulators are recommended and used to effectively control certain plant-growth processes, and thus aid crop production and storage. When used at different rates and different stages of crop growth, they modify various stages of plant growth from germination to fruit ripening, and also the storage of harvested products. Thus, it is important to apply the recommended rate at a precise stage of crop growth. Growth regulators are presently used in forcing rhubarb, for ripening of tomatoes, and for sprout inhibition in stored beets, carrots, onions and potatoes. **Read the label carefully before using any growth regulator.**

IRRIGATION

Most vegetable crops require a uniform supply of moisture throughout the growing season. The average rainfall in Ontario is 70 mm per month during the growing season. This provides only 65% of the needed water for best yield. Irrigation is as important a consideration as cultivar, fertilizer or pest control in producing good yields.

Water available for crop growth depends upon the soil's ability to retain water following rainfall or irrigation. Sands and coarse sandy loams retain less than 25 mm of water in the top 30 cm of soil, or a supply for no more than 7 days' crop growth. On these soils a weekly schedule of 25 mm of water from rainfall or irrigation maintains high crop yields. Heavier applications of irrigation water waste fertilizer by leaching nutrients from the root zone. Excessive irrigation may cause crop injury by moving herbicides from the soil surface to crop roots.

Fine sandy loams and silty loams retain 40 to 60 mm of water for crop growth. On these soils heavier and less frequent irrigations improve crop yield. Irrigations can be scheduled every 10 to 14 days at rates to provide a total of 40 to 50 mm of rainfall or irrigation.

Shallow-rooted crops respond most to irrigation. Potatoes and celery, for example, are shallow rooted and need adequate soil moisture for continuous growth. Early potatoes grown on sandy loams require 25 mm of rain or irrigation water at tuber set until harvest for best yields. Celery grown on sandy loams needs a similar weekly schedule of irrigation.

Shallow-rooted vegetables with a slightly lower but continuous need for adequate soil moisture are lettuce, onion, late potatoes, spinach, cabbage and cauliflower. Some deep-rooted crops such as carrots and beets, when grown on mineral soils, respond to heavier but less frequent irrigation with increased quality and yield.

Other vegetable crops have stages of growth when irrigation is most effectively used: beans — during and immediately after flowering; sweet corn — just before and during silking; tomatoes — during early fruit sizing; cucumber — after seeding and during fruit production. Crop symptoms of inadequate water during a critical period of crop growth are flower and fruit drop, blossom-end rot of tomatoes and peppers, poorly-shaped potatoes and carrots, tipburn of lettuce and splitting of cabbage. Timely irrigation can reduce or control these disorders.

Bad timing of irrigation can reduce yield. The critical period is during early root growth when frequent and light irrigation or rain results in shallow rooting. A guide for this critical period is to apply irrigation before or immediately after seeding and transplanting if the soil is dry. The application should be long enough to wet the soil thoroughly to encourage deep rooting. Herbicides must not be applied before a heavy irrigation at planting. (For more irrigation information see OMAF Factsheet, *Irrigation of Vegetables in Southern Ontario,* Agdex 250/560.)

A wide choice of sprinkler equipment is available — from simple hand-moved laterals to labor-saving mechanized systems. The costs range from $300/ha for hand-moved laterals to $2,000 to $3,000/ha for solid-set sprinklers. These costs do not include the expenses for water supply, mains, pump or power unit.

Hand-moved laterals — The least expensive sprinkler system, priced at $300/ha with maximum use. The labor cost with this system is high in order to move the laterals through the field. Tall-growing crops are not easily irrigated. However, water distribution is uniform and the system is adapted to fields of different sizes and shapes.

Large gun or giant sprinklers — An inexpensive system at a cost of $350/ha and useful in tall-growing crops. Labor cost for moving the equipment is expensive. It has only fair uniformity of water distribution and is most affected by wind.

Solid-set — The most expensive sprinkler system at a cost of $2,000 to $3,000/ha. Little labor is required with this semi-permanent placement of lines. It is also useful for frost protection and crop cooling.

Water, tractor-, and electrically-moved systems — These self-propelled systems are not common in Ontario. They are semi-permanently located to move through and irrigate large (64-hectare) fields from a central well and pump. Fields for this equipment must be large, square, fairly level and free of obstructions. Cost varies from $500 to $750/ha. Labor costs in the season are low except when the equipment is moved from one field to the next.

Boom-type sprinklers — This mechanical system is not common in Ontario. Its cost is approximately $375/ha and the labor cost for operation is high. It requires large fields and is not adapted to hilly land. Water distribution is most affected by wind.

Irrigation systems can be used for more than just applying water to satisfy a crop's water needs. Soluble fertilizers are most effectively applied by irrigation. Application of pesticides through irrigation is not recommended but is being investigated. Water applied through low-volume sprinklers is the most effective protection against frost hazard and can, in contrast, increase crop growth during hot weather by cooling the crop.

Ammonium nitrate, ammonium sulfate, calcium nitrate, urea and soluble potassium fertilizers are effectively applied through a sprinkler system. The fertilizer is dissolved in a drum or barrel, then introduced through a valve into the irrigation line either by suction or pressure. Feed the dissolved fertilizer into the line slowly, taking 10 to 20 minutes. After all the fertilizer has passed into the line continue to irrigate for 10 to 15 minutes to flush the lines and to wash the fertilizer off the leaves. Some minor-element deficiencies can be corrected by the application of manganese, boron or copper salts through the sprinkler system. Boron deficiency is probably the most common minor-element problem in Ontario, and can be corrected by the application of 1.1 kg/ha of boron; e.g. 11 kg/ha of borax (10.6% boron) or 4.4 kg/ha of Solubor (20.5% boron).

Irrigating to cool crops during hot weather may increase crop yield. Cooling results when field heat evaporates irrigation water from crop and soil. Irrigation-cooling has only recently become practical, with solid-set systems and automatic controls and valves which continually turn on and off series of sprinklers in a field. The water required for irrigation-cooling is less than the amount needed for soil irrigation. Rates of 2 mm of water per hour for 2 to 3 hours are effective. Irrigation-cooling is scheduled when air temperature is 30°C or higher at noon.

SLUGS

Metaldehyde is specific for slug control. Most other chemicals have little effect on them. Slug baits, dusts, and sprays containing metaldehyde are registered for use in Canada, but in Ontario the slug bait appears to be the only one widely distributed.

WHITE GRUBS

To avoid injury by white grubs, do not plant vegetables on land that has been in grass sod for two or more years.

If vegetables are planted on newly plowed land, use chlordane applied as a broadcast application at 22 to 44 kg/ha (active ingredient). Use the higher rate for immediate control in heavy soil or muck or where populations are high. Chlordane may not give adequate control with exceptionally heavy infestations.

Apply chlordane in sufficient water to give good coverage. Immediately after application to the soil surface, cultivate to a depth of 10 to 15 cm. Granular chlordane (25 G) may be drilled directly into the soil 10 to 15 cm at planting time. **Do not treat more than once every four years.** Do not use on corn or root crops, other than beets, potatoes, onions (dry bulb) and radish.

CUTWORMS

Several species of cutworms attack vegetables. The dark-sided, redbacked, black and glassy cutworms appear early in the growing season. Depending on soil and climatic conditions, these species will attack the plants below or at the soil surface, or will feed on the foliage. Late-season damage is caused primarily by the variegated cutworm which is a foliage feeder.

Effective cutworm control is dependent on proper timing of insecticide applications under favorable soil and climatic conditions. The insecticides recommended for use are short-residual, and break down quickly in sunlight. Also, most species of cutworms go into the soil during the day and come out to feed at night. Thus, insecticide applications should be made in late afternoon or early evening when temperatures are lower and just prior to the time the insects come up to feed. The insecticides are also more effective on moist soil as compared to dry soil.

Note: **The insecticides recommended are not registered on all crops. Consult the label to determine registration on a specific crop, the preferred methods and rates of application, and the required interval between application and harvest, or request advice from your nearest Pest Management Specialist of Crop Advisor.**

The following control programs can be used:

A. **Early-Season Species of Cutworms:**

1. *Preplanting cover-crop treatment:* Five days before plowing under the rye or wheat cover crop, when it is 10 to 15 cm high, apply chlorpyrifos once in 200-400 L of water per hectare. Applications should also be made to fencerows and to a 15-m strip into any nearby cover crop.
2. *Preplanting soil treatment:* Apply chlorpyrifos once in 200-400 L of water per hectare as a broadcast soil-surface application. **Do not incorporate on muck soils.**

NOTE: Where there has been a history of cutworm damage, 1 and 2 above are the preferred methods of treatment. Preplanting treatments will not be phytotoxic to vegetable crops.

3. *Postplanting treatment:* When cutworm damage first becomes apparent apply either:
   a. chlorpyrifos in up to 1000 L of water per hectare in a 15-cm band over the row.

   or

   b. permethrin in sufficient water for good coverage of foliage. Permethrin is registered only for use on seedlings (up to 5-leaf stage). Use the higher rates of permethrin on dry and muck soils and when cutworms are large (2.5-4 cm long). **Do not disturb** the soil for at least 5 days after treatment.

NOTE:

1. Both chlorpyrifos and permethrin are effective only on surface-feeding stages of cutworms.
2. Chlorpyrifos may be phytotoxic to some varieties of plants under stress conditions, i.e. hot, dry weather or cool, excessively wet weather.

B. **Late-Season Species of Cutworms:**

When cutworm damage first appears, apply carbaryl, [1]methomyl or permethrin in sufficient water for good coverage of foliage. Spray penetration of the foliage canopy is essential for good cutworm control. Best control will be obtained when cutworm larvae are small.

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[1] *Minimum period before reentry is 24 hours.*

WIREWORMS

Wireworms are more likely to be a problem for the first two years following sod. There are two control programs:

a. **Seed Treatment:** For large-seeded vegetables (beans, etc.) use a lindane seed treatment.

b. **Broadcast or band soil treatment:** This treatment is necessary for potatoes. Use one of the following:

*chlordane 25 G — 22-44 kg/ha (broadcast)
carbofuran 10G — 32.5 kg/h (band treatment only)
fonofos 10 G — 55 kg/ha

**Do not treat more than once every four years.*
Chlordane is not registered on corn or root crops other than beet, potato, onion (dry bulb) and radish.

Emulsifiable concentrates, wettable powders, flowables and granular formulations are equally effective. For surface treatments, apply in sufficient water to give good coverage. Immediately after application to the soil surface, cultivate to a depth of 10 to 15 cm. Granular formulations may be drilled directly into the soil 10 to 15 cm at planting time.

CROP ROTATION FOR CONTROL OF DISEASES

Crop rotation is an important method for controlling certain fungi, bacteria and nematodes that cause plant diseases. The disease organisms that are controlled by a rotation will persist only for a short time (1 to 2 years) in the soil in the absence of the crops they attack. Rotation often must be combined with other controls to provide a high level of control. For example, crop rotation is important for reducing losses due to anthracnose disease in snap beans. The anthracnose fungus survives in the soil about as long as it takes for the remains of the bean plants to decompose. A rotation that includes 2 years of crops which the anthracnose fungus cannot attack is effective in "starving out" the fungus.

Like many other disease-causing organisms, the bean anthracnose fungus also survives in seeds from one season to the next. Therefore, one should sow disease-free snap bean seed to avoid bringing more of the fungus into a field that has been "cleaned up". The fungus also survives in bean straw and in trash left when beans are cleaned. So bean straw and trash should not be spread on land that is intended for snap beans during the next 2 or 3 years.

A rotation is not effective against many other organisms for a variety of reasons. The onion-smut fungus and the cabbage-yellows fungus are good examples of fungi that survive so long in the soil that a rotation is not practical. Spores of the onion-smut fungus survive for 10 to 12 years and the cabbage-yellows fungus persists indefinitely.

Powdery-mildew fungi are examples of fungi that have windborne spores that are blown from neighboring fields and farms. Many of the viruses that cause disease in vegetables are spread by aphids wherever they fly, and the mycoplasma that causes aster yellows in carrot, celery and lettuce is spread about by leafhoppers — regardless of rotation.

NEMATODES

Root-lesion, root-knot, and sugar beet cyst nematodes are responsible for most nematode problems in Ontario vegetable crops. A crop may be attacked by the combined action of two or more kinds of nematodes. In some cases, nematodes aggravate diseases caused by fungi, e.g. root-lesion nematodes worsen Verticillium wilt of eggplants.

The root-lesion nematode is widely distributed in Ontario and attacks many vegetable crops. It causes tiny, brownish, scratch-like wounds on the roots, and is very destructive to such crops as celery and lettuce.

The root-knot nematode is frequently found in vegetable-producing areas, particularly in muck soils and greenhouses. These nematodes cause galls on the roots resulting in poor plant growth that quite often shows up as patchy areas in a field. Many crops are attacked by this nematode, sometimes resulting in severe losses, particularly with carrots.

The sugar beet cyst nematode is quite destructive to table beets and spinach but other root and cruciferous crops are also affected. It is frequently found in association with rhubarb. This nematode can be seen on the roots as tiny, white or brown, pearl-shaped objects.

The bulb and stem nematode, which causes onion bloat, has been reported from several of the onion-growing marshes. Onion-bloat symptoms may appear early in the crop when leaves become twisted and deformed. Infected plants which survive are usually deformed, with shorter, thickened leaves. Splitting and cracking of infected bulbs is one of the most easily recognizable symptoms. Practical control measures depend largely on the limited host range of the Ontario population of this nematode as well as sanitation and soil fumigation. For additional information see OMAF Factsheet, *Bulb and Stem Nematode*, Agdex 258/628, or your local Crop Advisor or Pest Management Specialist.

Nematode problems are often difficult to diagnose and to control. Commercial growers are advised to consult the Crop Advisor or Pest Management Specialist in their area if a nematode problem is suspected.

Steam sterilization of greenhouses is still a very effective means of controlling nematodes, although chemical fumigation has become a common practice with many growers.

In the field a program of crop rotation with periodic soil fumigation is recommended. Consult your Crop Advisor or Pest Management Specialist, or the Research Station, Agriculture Canada, at Vineland Station, concerning crop-rotation programs for individual crops. For additional information on nematode diagnosis refer to the Factsheets listed on page 67 .

The chemicals most commonly used in preplant soil fumigation for nematode control are Telone II, Telone C-17, and Vorlex Plus. In Ontario, much of the soil fumigation against nematodes is done by custom operators. Recommended dosage is usually indicated as a range, eg. 110-220 L/ha. Use a level near the upper limit for muck soil. Always follow manufacturer's directions carefully concerning dosage and methods of use.

Soil fumigation can be done either in the fall or in the spring. Most growers prefer to fumigate in the fall to avoid delays in planting in the spring.

At the time of fumigation, the soil temperature should be at least 4°C at the 15-cm depth, the soil must be thoroughly worked to a depth of 20 to 25 cm and the moisture content of the soil must be at a level that would permit good seed germination. With fall applications, the soil should be worked several weeks before fumigation so that the area is reasonably free from undecomposed crop residue. For a copy of the publication "Land Preparation — A Key to Successful Soil Fumigation", contact Nematology Section, Research Station, Agriculture Canada, Vineland Station, L0R 2E0.

The soil surface must be sealed immediately after injection by floating, packing or a water seal, and left undisturbed for one week, or longer if the weather is wet and cool. Before planting, till the soil thoroughly to aerate, and ensure that all traces of fumigant odor have dissipated. With fall applications the soil should not be disturbed after sealing until the normal spring cultural operations are started.

Methyl bromide, and at high dosage Vapam and Vorlex, are used as general-purpose soil fumigants. Do not use nematicides containing bromine before planting onion, garden beet, celery and potato. Methly bromide must be applied under a plastic cover according to the manufacturer's directions.

Only those who have a permit may apply methyl bromide. A permit may be obtained from Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario, M4V 1P5, telephone (416) 965-2401.

HOT-WATER SEED TREATMENT

Buy hot-water-treated seed or treat seed as follows:

Place seed in a cheesecloth bag of ample size; the bag should not be more than half full. Wet seed and bag with warm water. Soak cabbage, broccoli, Brussels sprouts, tomato, pepper and eggplant seed for 25 minutes in water maintained at 50°C. Then spread seed out to dry. Treat cauliflower, kohlrabi, kale, and summer turnip seed as above but for 15 minutes. Treat celery seed at 48°C for 30 minutes. Tomato seed can be treated at 54°C for 25 minutes but must be planted within a few days. **Use an accurate thermometer.** Stir the water and bags of seed continually to secure rapid penetration of heat to maintain uniform temperature in the seed lot. (See OMAF Factsheet, *Vegetable Seed Treatments*, Agdex 250/23.)

CHEMICAL SEED TREATMENT

All vegetable seed should be treated with a fungicide to help prevent seed decay and damping-off.

To control black rot in cabbage, cauliflower, Brussels sprouts, broccoli and rutabaga treat the seed with streptomycin. Check the label for method of treating the seed and rates, etc.

To control seedcorn maggot, treat seeds of bean, corn, pea, cucumber, melon, squash and other large-seeded crops with diazinon insecticide and with lindane insecticide for wireworm control. **To avoid insecticide injury to the seed, apply insecticides only in combination with a fungicide.** The combination seed treatment containing captan or thiram and both insecticides should be used each season because not all wireworms are killed and seed maggots are usually present.

Treat seed not longer than three months before planting, with a combination lindane-diazinon-captan or lindane-diazinon-thiram.

Commercial seed dressings containing these chemicals are available. Check labels for registered crops and rates of application.

Use a combination lindane-diazinon seed treatment on seed already treated by the seed company with a fungicide or a fungicide plus malathion. Although commercial seed-treating equipment gives the best coverage, seed may be treated on the farm. Mix the required amount of chemicals in 0.8 L of water and thoroughly mix it with one hectolitre of seed. Use a cement mixer or shovel. Spread out the treated seed to dry before bagging.

Alternatively, buy seed treated with a fungicide and the two recommended insecticides. Purchased seed may have been treated to control storage insects. Such treatment does *not* control seed maggots and wireworms in the field. *Consult the tag or label on the package to see what was used to treat the seed.*

WARNING

The concentrations of pesticides in seed treatments are high and thus the products are quite toxic. Wear rubber gloves, full protective clothing and a respirator when treating seed. Avoid skin contact and breathing the fumes. Do not handle treated seed with bare hands. Dispose of surplus treated seed by burying it under 50 cm of soil in an area away from water supplies.

DAMPING-OFF OF SEEDLINGS

Affected seedlings rot at ground level and topple over. The damping-off fungus may cause seed decay also.

Steam or fumigate used flats and soil for growing seedlings (consult OMAF Publication 365, *Greenhouse Vegetable Production Recommendations).* Treat seeds with a protectant fungicide (see also Chemical Seed Treatment). Bench tops or other surfaces used to accommodate seedling flats should be sterilized with steam, formaldehyde or other effective disinfectant; alternatively, cover bench tops with clean plastic sheeting.

Water seedlings only when necessary and preferably before noon. Provide good ventilation and keep humidity low. If damping-off appears, water flats at rate of 5 L/m^2, 2 or 3 times, at 4-day intervals with oxine benzoate, ferbam or thiram. Follow manufacturer's directions regarding concentrations.

Where steam is used to treat soil, maintain a temperature not less than 82°C for 20 minutes throughout the soil. Avoid prolonged steaming.

Carefully follow manufacturer's directions for use of soil fumigants. *Only those who have a permit may apply methyl bromide.* A permit may be obtained from Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto M4V 1P5. Telephone: (416) 965-2401.

In time treated soils become recontaminated by damping-off fungi. This can be delayed to a great advantage in flats of pepper and Spanish onion seedlings by treating the steamed soil with thiram 75% WP, 5 grams to a flat of soil, or 800 g/100 m^2 of bed. Thiram must be mixed thoroughly with the soil to a depth of 8 cm.

Disinfect used flats with steam; or immerse moistened flats in a solution of 37% formaldehyde 5 L in 125 L water, then set flats aside until the smell of formaldehyde disappears.

The amounts of pest-control chemicals stated in the recommendations are for **one hectare** actually covered, unless otherwise stated. For metric conversion factors, see tables at the back of this publication.

REFER TO THE CENTERFOLD FOR THE TRADE AND BRAND NAMES OF PESTICIDES RECOMMENDED IN THIS PUBLICATION.

ASPARAGUS

CULTIVARS

Viking (selected)
Lucullus (midseason strain)

GROWING SEEDLINGS

Soak seed in water about 32°C for 3 to 4 days. Dry and sow immediately in early spring in fertile, well-prepared soil. Plant seed 2.5 to 4 cm deep and 8 to 10 cm apart in rows 45 to 60 cm apart. One kilogram of good seed should provide enough crowns to plant one hectare. Plan to grow more plants than you need, to allow for selection of strong plants. Date of seeding is the last two weeks of May. Sow 11 kg of seed per hectare (approximately 250,000 crowns per hectare). Keep weeds and grasses controlled at all times.

FIELD SELECTION AND PREPARATION

Asparagus is a **long-term** vegetable crop which should produce viable yields for fifteen or more years. Therefore, thorough planning is essential for success. Field selection and preparation are key building blocks upon which good long-term production is dependent.

Plant only into well-drained sandy or sandy loam soil free of perennial weeds and grasses. Eradication of perennial weeds and supplemental drainage improvement must be completed before the year of transplanting.

Soil testing is highly recommended to determine fertility levels and pH before transplanting.

Ideal soil pH should range between 6.0 to 6.8.

If possible, seed a green-manure crop the year before transplanting to increase soil organic matter. Animal manure can also be used.

TRANSPLANTING AND SPACING

In early spring dig the one-year plants, discard the weak ones (up to one-half the total), and plant the others in furrows so that the tops of the crowns are 15 cm deep. Space the plants 22 to 30 cm apart in rows 1.2 to 1.5 m apart. Spread out the roots and cover with not more than 5 cm of well-firmed soil. Fill in furrows gradually by cultivating as plants grow. **Control weeds to retain high plant populations and vigorous growth.**

TILLAGE AND FERN DISPOSAL

It is best to retain asparagus fern all winter in order to trap the snow and thereby protect the crowns from low-temperature winter injury. The fern can be cut up with a rotary or flail-type mower before **minimum and light disking in early spring.** The fern contributes organic matter to the soil. **Use minimum cultivation for fern disposal and weed control. Excessive and deep tillage can injure crowns which can increase Fusarium infection and lower yields.**

HARVEST OF SPEARS

Most asparagus plantings are vigorous enough so that they can be harvested for about 10 to 14 days in the spring of the third year after field setting (i.e., field set spring 1986, first limited harvest spring 1988). **If asparagus vigor has been reduced by weed competition, insects or disease, or any other stress factor, harvest should be delayed to the fourth year** after field setting. A **4-week harvest** can then be undertaken.

An established asparagus planting is usually harvested for approximately 6 weeks. Harvesting should be terminated sooner if the emerging spears are too thin to meet the grade standards.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See pages 21, 22). Take the soil sample at the depth of planting.

NITROGEN — For asparagus seeded in a NURSERY, apply up to 75 kg N/ha. For NEW PLANTINGS of crowns and ESTABLISHED plantings apply up to 110 kg N/ha.

APPLICATION — For the NURSERY, broadcast the N with all of the phosphate and potash required and work in before seeding. An additional 50 kg N/ha may be applied as a side-dress application in August or early September if rainfall is excessive. For NEW PLANTINGS, broadcast all of the N with the potash pre-planting. All of the phosphate should be banded below the crowns at planting. If a green-manure crop is planted in the previous year, apply 30 to 40 kg N/ha and as much phosphate and potash as that crop requires, based on soil tests, before or at seeding. If manure is applied or legume sod is plowed down, reduce the nitrogen application (see Tables on pages 14 and 16.) For ESTABLISHED plantings, apply one-half of the N with all of the phosphate and potash required, broadcast, in early spring. Broadcast the remainder of the N immediately after harvest.

DISEASE CONTROL

RUST — All commercial cultivars are susceptible to rust. Disease control is achieved only with thorough spray coverage on a regular preventive schedule. This spray must protect new foliage as it grows, before rust spores can land on it and germinate. Start spraying new, non-harvested plantings as soon as growth is about a foot in height (late May). For harvested plantings, begin spraying as soon as fern growth commences after harvest is complete. A 7- to 10-day schedule is essential until at least late August to protect the fern growth. A high-boy sprayer with drop arms having three nozzles is needed for full spray coverage.

Spray with one of:

1. zineb 80 WP 2.5-2.75kg
2. metiram 80 W 1.5-2.75 kg

Use high rate on full-grown fern.

BOTRYTIS — This disease attacks plants which are damaged from rust or beetle feeding. Under wet weather conditions it can cause serious plant injury. A regular spray program for rust and good control of beetles before serious feeding occurs is the best control recommendation.

FUSARIUM DISEASES — Avoid replanting on land which previously grew asparagus. Otherwise, fumigate soil with Vorlex 0.6 L per 10 m^2 before planting. Consult manufacturers' directions. Follow all safety precautions.

In addition to soil fumigation, the following treatment may give additional protection against Fusarium and other soilborne organisms, and furthermore, on new asparagus land, crowns may also be treated as follows:

Mix benomyl 50% WP 2 grams per litre of water. Dip 3000 crowns in 100 L solution for 15-20 minutes before planting.

ASPARAGUS (Continued)

Use seed treated with sodium hypochlorite bleach.

Use vigorous one-year-old crown when transplanting.

Care should be taken to avoid stresses, because these make asparagus more susceptible to Fusarium diseases.

Stresses which promote these diseases are overpicking, or picking before crowns are well established; insect and other disease damage; weed competition; excessively deep tillage; poor soil drainage; soil compaction; acidic soil pH; drought; injury from misapplication of pesticides, fertilizers, manure; and low fertility.

INSECT CONTROL

ASPARAGUS BEETLES — Because there are several generations of these beetles, they are a **constant threat** throughout the season. Begin spraying when adult beetles are observed **before** egg laying in spring.

Spray:

1. methoxychlor 50% WP 3.25 kg or 25 E 3.5-8.5 L (3 days)
2. malathion 500 EC 2.75 L or 25% WP 4.5 kg (1 day)
3. rotenone 5% WP 6 kg plus spreader (1 day)
4. *carbaryl 50% WP 2.2 to 5.5 kg or 85% WP 1.3 to 3.2 kg (1 day). Use only during harvest; do not use during fern-growth period.

**See note on Bee Warning*

Dust: rotenone 1% 40 kg (1 day)

APHIDS — Spray with one of:

1. pirimicarb 50 WP 1 kg in 675 L of water
2. dimethoate 480 EC 2.3 L in 675 of water

Sprays for aphids should be applied at three- to four-week intervals as needed until defoliation in October. For immature asparagus, begin application mid May. For mature asparagus, begin application July 1, after the crop has been harvested.

CUTWORMS — When cutworm damage first becomes apparent, apply carbaryl 50% WP 2.2-5.5 kg or 85% WP 1.3-3.2 kg (1 day). See also page 24.

PIGWEED CASEBEARER — Control pigweed completely in the planting and in headlands because if carebearers develop on pigweed they may contaminate the crop in May and early June the following year.

Bee Warning

Bees are attracted to asparagus bloom. Where spraying is being done, bee poisoning may result. Dimethoate is toxic to bees and should not be used during the bloom period. Carbaryl is especially toxic to bees and should not be used during the fern-growth period. With other insecticides, losses to bees can be reduced if sprays are applied in early morning or late evening when the bees are not foraging. Advise local beekeepers of spraying activity. Your local Agricultural Representative has a list of beekeepers in your area.

STORAGE OF SPEARS

Freshly harvested asparagus is very perishable and loses quality rapidly. Collect the spears as soon as possible, protect them from the sun, and move them to cold storage, the processor or a market as soon as possible. If short-term storage is necessary, store under high humidity at 1 to 2°C.

BEAN (SNAP AND LIMA)

CULTIVARS

(not revised for 1986)

GREEN BUSH	YELLOW BUSH
Processing	*Processing*
Win	Bonanza Wax
Early Gallatin	Goldrush
Bush Blue Lake 47	Golden Rod *(trial)*
Bush Blue Lake 92	
Strike	
Eagle	*Fresh Market*
	Cherokee
Fresh Market	Kinghorn
Peak	
Improved Tendergreen	LIMA
Contender	Early Thorogreen
Provider	Fordhook 242
Strike	Mendoza Bush

SEEDING AND SPACING

Snap Beans (Green and Yellow)

Sow as shallow as soil moisture permits, usually 2.5 to 4 cm deep. The following row spacings and seed rates are suggested for optimum yields depending on the harvest method or on the type of mechanical harvester used.

Seeding rates must be adjusted according to cultivar and germination percentage. Snap beans grown for processing can only be grown in narrow rows (less than 80 cm) when a Multi-D harvester is used. With narrow rows a complete chemical weed-control program is necessary which will provide consistent control of weeds.

Optimum germination temperature is 16 to 29°C. At low soil temperatures, seed decay is more serious.

BEAN (SNAP AND LIMA) (Continued)

SPACING AND SEEDING RATES

Row Spacing cm	**Plants per metre of row**	**Seeding Rate per hectare**	**Harvest Method**
90 to 95	20 to 26	80 kg	Mechanical (all kinds) and hand pick
45, 50 and 60	17 to 22	100 kg	Mechanical (Multi-D) and hand pick
22 to 25	10	110 kg	Mechanical (Multi-D)
15 to 18	—	165 kg	Mechanical (Multi-D)

Lima Beans

Use 55 to 65 kg of seed per hectare. Seed approximately 4 to 5 cm deep depending on soil moisture. Rows are spaced 60 to 70 cm.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 00 and 00.)

NITROGEN — 15 kg N/ha is recommended at seeding where phosphate and potash are required. If no phosphate and potash are required the nitrogen may be omitted. Sidedressing of nitrogen is only recommended following heavy rains if foliage indicates nitrogen deficiency.

APPLICATION — Fertilizer may be broadcast before seeding and worked in or banded 5 cm below and 5 cm to the side of the seed. High rates of banded potassium can reduce yield; therefore banded potassium should not exceed 60 kg K_2O/ha.

MICRONUTRIENTS — MANGANESE deficiency may be a problem on beans on some soils with pH values above 6.5. Correct the deficiency as soon as detected by spraying the foliage with 1 kg manganese/ha from manganese sulfate, or 0.2 kg manganese/ha in chelated form, in 1000 L of water. Use a "spreader sticker" in the spray. If the deficiency is severe a second spray may be beneficial. Soil application is not recommended for manganese because of the large amounts required.

BORON — Beans are very sensitive to boron toxicity and should not be grown the year after boron has been applied for other crops.

ZINC deficiency has been reported on beans in Michigan, but appears to be very rare in Ontario.

DISEASE CONTROL

1. Plant seed that is free from organisms causing **bacterial blight, anthracnose, common mosaic** and **yellow mosaic.** The best source of snap-bean seed free from anthracnose and blight is western United States.
2. Practise crop rotation of at least 3 years to help control Fusarium and other soil-borne root rots, bacterial blight, anthracnose, and Sclerotinia white mold. Where disease is a problem it may be necessary to practise a 4- to 5-year rotation. Include in the rotation crops **other than** field beans, snap beans, pole beans, kidney beans, lima beans, soybeans and peas.
3. Maintain vigorous plant growth. Fertilize adequately. Avoid poorly-drained or compacted soils.
4. Do not cultivate or harvest when plants are wet.
5. Plow under crop residues in the fall to hasten destruction of disease organisms. Do not spread bean refuse or manure containing bean refuse on land intended for beans during the next 3 years.

SCLEROTINIA WHITE MOLD — Plant fields in exposed areas where air circulation is maximum. For snap beans grown in fields where white mold has been a problem in recent years, spray at first bloom with one of:

1. benomyl 50% WP 2.25 kg (14 days)
2. dichloran 75W 3.25 kg (2 days)

Spray must penetrate the crop canopy and contact blossom petals. Use of drop nozzles and overhead nozzles, and high pressure (up to 2000 kPa) give best results. Applications made after bloom are not effective. If wet weather persists, a second spray will be beneficial; or spray with iprodione 1.5 kg (15 days) when 50% of the blooms have opened.

COMMON MOSAIC AND YELLOW MOSAIC — Common mosaic virus is seed-borne and is also spread by aphids from infected beans. Some of the recommended snap beans are resistant to this virus. Check with your seed supplier. Avoid planting beans next to forage legumes or sweet clover from which aphids may spread yellow mosaic.

BRONZING — Bronzing is a physiological disorder caused by high levels of atmospheric ozone associated with air pollution. It occurs following the initiation of flowering and after the older leaves become fully mature. A bronze-colored stipple develops on the pods and the upper surface of the leaves. Pod and seed set are usually reduced and the plants age prematurely. Dry beans and limas appear more sensitive than snap beans, and cultivars within these types differ in susceptibility.

INSECT CONTROL

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. (See Chemical Seed Treatment, page 26.)

LEAFHOPPERS, MEXICAN BEAN BEETLE AND GREEN CLOVERWORM — Spray with one of:

1. carbaryl 50% WP 2.25 kg or 85% WP 1.25 kg (3 days)
2. [2]azinphos-methyl 240 SC 2.25 L or 50W 1.1 kg (3 days)
3. endosulfan 4 EC 2.1 L or 400 EC 1.5 L (2 days) Do not use on lima beans.
4. dimethoate 480 E 0.75 L or 40 EC 0.85-1.25 L (7 days)
5. malathion 25% WP 4.5 kg or 500 EC 2.75 L (3 days)

Note: 4. and 5. are not effective on green cloverworm.

CORN BORER — Corn borer has been a problem on snap beans in some areas in the past few years. Control requires a number of repeated applications of insecticides timed carefully. Consult your processor and Crop Advisor or Pest Management Specialist.

The following insecticides are registered for control:

1. permethrin 500 EC 200 mL (7 days)
2. [1]methomyl 2.25 L (7 days)
3. [2]azinphos-methyl 240 SC 2.25 L (3 days)
4. carbaryl 50W 3.25 kg or SL 3.5 L or 80S 2.25 L (3 days)

APHIDS (lima beans only) — Spray with one of:

1. dimethoate 480 E 0.75 L (7 days)
2. malathion 25% WP 3.25-4.5 kg or 500 EC 2.75 L (1 day)

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[1] *Minimum period before reentry is 24 hours.*

[2] *Minimum period before reentry is 48 hours.*

Do Not Feed Bean Refuse to Livestock or Poultry if the Crop was Treated with endosulfan, dimethoate or benomyl.

BEET

CULTIVARS

(not revised for 1986)

King Red
Ruby Queen
Gladiator

PROCESSING
As recommended by processors

BUNCHING
Little Egypt
Crosby Egyptian
Early Wonder
Detroit Dark Red

SEED TREATMENT

Treat seed before planting with thiram seed protectant. Follow manufacturer's directions.

TRANSPLANTING

For very early beets, sow seed in the greenhouse six to seven weeks before transplanting to the field in mid-April. In the field, space the plants 8 cm apart in rows 30 to 40 cm apart.

FIELD SEEDING AND SPACING

For a continuous supply of beets for bunching, sow seed at two-week intervals, from early April to the end of July. For storage and processing, sow about 10 weeks before late-fall harvesting. Seed will germinate at temperatures lower than 4°C. Optimum germination temperature is from 10 to 29°C. Sow seed 12 to 20 mm deep. About 7 kg of seed will plant one hectare.

Thin plants 5 to 8 cm apart. No thinning required on muck soils when seeders are adjusted to ensure a stand of 32 to 40 plants per metre of row. Rows 30 to 40 cm apart, depending on foliage size of cultivar.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22.)

NITROGEN — On MINERAL SOILS apply up to 110 kgN/ha. On MUCK SOILS apply up to 55 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — On MINERAL SOILS broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be sidedressed.

MICRONUTRIENTS — BORON deficiency shows up as a breakdown and corky, dark discoloration of internal tissues (see page 20).

MANGANESE — Deficient plants show marked yellowing between the leaf veins; the veins themselves remain green. To correct a deficiency spray with manganese sulfate (see page 21).

DISEASE CONTROL

DAMPING-OFF AND SEEDLING DISEASES — See Seed Treatment.

NEMATODES — To avoid damage from sugar-beet cyst nematode, do not plant beets following rhubarb, spinach or beets (see Crop Rotation and Nematodes, page 25).

INTERNAL BREAKDOWN (BORON DEFICIENCY) — Most likely to occur on alkaline soils after prolonged hot, dry periods (see Boron, page 20).

INSECT CONTROL

LEAF MINER — Usually required only for bunching beets. When mines first appear spray with one of:

1. dimethoate 480 E 0.7 L (3 days)
2. [3]parathion 15% WP 2.25 kg or 960 E 350 mL (15 days)
3. malathion 25% WP 4.5 kg or 500 EC 1.75 L (7 days)

APHIDS — If a problem, spray with one of:

1. dimethoate 480 E 0.75 L (3 days)
2. [3]parathion 15% WP 2.25 kg or 960 E 350 mL (15 days)
3. diazinon 50% WP 1.1 kg or 500 EC 1.1 L (14 days)

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[3] *Minimum period before reentry is 7 days.*

QUALITY AND STORAGE

Heavy rains following a hot, dry period, or extended periods of high temperature will cause poor color. Rains in the late summer or early fall, when cooler temperatures occur, may increase the intensity of color. In general, cool temperatures produce the best flesh color.

Mature topped beets may be stored for up to 5 to 6 months at 0°C and 90 to 95% relative humidity.

To inhibit sprouting in storage, apply maleic hydrazide 4 to 6 weeks prior to harvest according to manufacturer's recommendations. Apply to healthy plants with tops in good condition.

The use of maleic hydrazide prevents the formation of new leaves during the latter part of the growing period. This results in an increase in dry matter within the beets. Storage quality and duration are also improved.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS

COLE-CROP CULTIVARS

Listed in approximate order of maturity

CABBAGE

Early
Early Greenball[1]
Early Marvel[1]
Tucana[1]
Green Express YR
Headstart
Sun-up

Late
Rio Verde YT [2]
Bartolo YT
Winterkeeper
Safekeeper
Superdane YR
Hinova YR

Midseason
Green Express YR
Shamrock
Superette
Sanibel YR
Market Prize
Prime Time

Savoy
Savoy King
Chieftain
Ice Prince (*trial*)
Ice Queen (*trial*)

Red
Ruby Ball
Red Acre YT
Ruby Perfection
Red Winter

CAULIFLOWER[3]

Early Crop (mineral soil)
Extra Early Snowball[1]
Snow Crown
Paloma

Midseason (mineral soil)
Snow Crown
Taipan

Early Crop (muck soil)
Extra Early Snowball
Snow Crown

Late Crop (mineral soil)
Snow Crown
Andes
Hormade
White Fox
White Summer
White Rock
White Top
Self Blanche

Late Crop (muck soil)
Snow Crown
White Summer
White Top
Hormade
Andes

BROCCOLI (*mineral soil*)
Southern Comet
Prominence
Topstar
Paragon
Emperor
Premium Crop

BROCCOLI (*muck soil*)
Galaxy (*trial*)
Emperor (*trial*)
Paragon (*trial*)
Topstar
Southern Comet
Futura
Premium Crop

BRUSSELS SPROUTS
Jade E
Lunet [4]
Silverstar YT[4]
Valiant[4] (*trial*)

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[1] *For early areas only.*

[2] *Not recommended for long-term storage.*

[3] *Cauliflowers listed are for fresh market, to produce curds not more than 20 cm diameter. For processing cultivars, growers should follow processors' requirements.*

[4] *Probably matures too late for zones other than A, B, and C. (See Figure 1, page 9.)*

YT: Fusarium Yellows tolerant**
YR: Fusarium Yellows resistant**
** *Based on seed company claims*

SEED TREATMENT

Sow seeds that have been hot-water-treated and dusted with thiram or captan seed protectant. Follow manufacturer's directions. Hot-water treatment (see page 26) is most important to help prevent black rot, blackleg and bacterial leaf spot.

To control black rot, seed may be treated with streptomycin as an alternative to hot-water treatment. Follow manufacturer's directions on the label.

SEEDING AND SPACING

About 300 to 350 grams of seed will provide enough transplants for 1 hectare at standard spacing.

CABBAGE (EARLY), BROCCOLI — Rows 60 to 75 cm apart. Plants 30 to 45 cm apart.

CABBAGE (LATE), CAULIFLOWER, AND BRUSSELS SPROUTS — Rows 75 to 90 cm apart. Plants 45 to 60 cm apart.

The newer compact hybrids may be grown at closer spacings than the older traditional cultivars.

With Brussels sprouts grown for a once-over harvesting and especially where smaller sprouts are required for freezing, uniformity of the sprouts up the stem can be improved by growing the plants on a closer square spacing, e.g. 60 x 60 cm, or even as close as 53 x 53 cm.

For broccoli crops anticipated to be harvested during the hot humid weather of late August - early September, plant spacings should be increased to the wider end of the range recommended.

DIRECT FIELD SEEDING

Direct seeding in the field is practical for late summer and fall crops of cabbage, cauliflower, broccoli and Brussels sprouts. If precision seeders are used, it is false economy not to use graded seed. Some seeder units may be operated with seeds of well-defined sizes to give precise spacings on the ground. Extra care must be taken with soil preparation, and it may be necessary to irrigate before seeding to ensure good moisture conditions for germination. Depth of seeding should be 6 to 12 mm.

Direct seeding is particularly applicable where high plant populations are required. Seeding date should be 10 to 14 days after the normal date for seeding for a transplant crop of the same season of maturity. Even for the most favorable areas of Ontario, crops should probably not be direct seeded after about June 30.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22.)

NITROGEN — On MINERAL SOILS, broccoli, cauliflower and Brussels sprouts should receive 130 kg N/ha; and cabbage 170 kg N/ha. For MUCK SOILS suggested maximum is 130 kg N/ha. If manure is applied or legume sod is plowed down, reduce the N application. (See tables on pages 14 and 16.)

APPLICATION — Broadcast three-quarters of the N and all of the phosphate and potash required before planting, and work in. The remainder of the N should be side-dressed about three weeks after field setting. If rainfall is excessive, an additional 40 kg N/ha may be side-dressed on sandy soils. For MUCK SOILS, up to 70 kg N/ha should be applied before planting and the rest split into two equal side-dressings as needed.

STARTER SOLUTION — If no insecticide is being added to the planting water, use a starter solution high in N such as 20-20-20 at 1 kg/200 L and apply 0.2 to 0.3 L per plant. Under high-temperature conditions or in dry sandy soils use only ½ kg of 20-20-20/200 L of water. This will reduce the risk of crop injury under these growing conditions.

MICRONUTRIENTS — BROWN HEART or HOLLOW STEM (BORON DEFICIENCY) — On soils known to be deficient in boron, apply 2.5 to 3.0 kg of boron/ha and disk-in before planting. Foliar sprays of boron can be made during the growing season (see page 20). Boron deficiency has been shown to cause Hollow Stem in broccoli, but all Hollow Stem is not caused by boron deficiency.

WHIPTAIL (MOLYBDENUM DEFICIENCY) — Deficiency causes whiptail in cauliflower, broccoli, and Brussels sprouts. If molybdenum is deficient, apply sodium molybdate mixed with the fertilizer at rates supplying 0.6 to 0.8 kg of molybdenum/ha or apply 10 to 15 g of molybdenum per 100 L water at 0.3 L per plant at transplanting. If deficiency symptoms appear in the field, spray immediately with 100 g of molybdenum dissolved in 1,000 L of water applied to one hectare.

SPECIAL PROBLEMS

CABBAGE SPLITTING

When the heads are well developed, they may split or burst if rain or a heavy irrigation follows a dry spell. Splitting results from rapid new growth due to the increased moisture. Splitting may be partially avoided by checking the plants' growth, e.g. by deep cultivation to break some of the roots. Proper irrigation may prevent splitting by helping to maintain steady plant growth.

CABBAGE BOLTING

Premature seedstalk development may occur when plants are started too early and grown at too low temperatures early in the growing season. The earlier the seed is sown, the greater the bolting tendency. Bolting may also be caused by extreme changes in temperature, poor soil conditions, low nutrient levels, or other factors which cause checks to plant growth. Some cultivars, particularly early ones, are more susceptible to bolting than others.

CAULIFLOWER BUTTONING

Buttoning is the premature formation of a cauliflower curd, and because the curd forms very early in the plant's life, the leaves are not large enough to nourish the curd to a marketable size. Buttoning usually occurs shortly after planting in the field, when normal plants of the same age are growing vegetatively. Losses are usually most severe in the early-planted crop during cold, wet seasons, when vegetative growth is checked. Conditions which may cause buttoning include:

— a too-rapid hardening-off treatment of young plants raised under protection

— insufficient hardening-off treatment of young plants before being planted in the field

— unbalanced soil fertility in the field (particularly low nitrogen)

— low soil moisture

— extreme and continued cold weather (e.g. 4 to 10°C for 10 days or more) especially in combination with excess moisture

— certain diseases, insects and trace-element deficiency, such as club root, root maggot and molybdenum deficiency (whiptail).

In short, conditions which reduce the vigor of the plant and retard vegetative growth appear to encourage buttoning. Some cultivars, particularly early ones, are more susceptible than others.

CAULIFLOWER BLANCHING

A perfect head of cauliflower is essentially pure white or pale cream. Heads exposed to sunlight develop an objectionable yellow pigment. While the head is small it is covered by the small inner leaves which curve over it, but as the head grows and enlarges, these leaves begin to lift, and some other means of covering is necessary to exclude sunlight. The usual method is to tie the outer leaves over the heads when the heads are 8 to 10 cm in diameter.

The heads tied at different times should be marked by different colors of twine or rubber bands to indicate probable maturity date and thus facilitate harvesting. In hot weather, blanching may take only 3 to 4 days, but in cool weather, when growth is slow, 8 to 12 days or more may be required.

Some cultivars are better able than others to give natural curd protection by the inner wrapper leaves, without tieing. Generally speaking, cultivars originating in Europe, and which appear in the recommended list in this publication, have better natural curd protection than the traditional North American cultivars.

BROCCOLI HARVESTING

The heads are cut with 15 to 20 cm of stem. Lateral shoots from the axils of the leaves develop into marketable heads soon after the terminal head is removed. These laterals produce a continuous crop for several weeks. However, some of the new hybrids produce very few laterals. Continuity of production with these cultivars may be obtained by successive plantings in the spring and summer.

Heads should be cut when the clusters are green and compact. Open and yellow clusters are undesirable.

BRUSSELS SPROUTS HARVESTING

Harvesting should begin when the sprouts are firm and well formed. In picking, the leaf below the sprout is broken off and the sprout removed. The upper sprouts continue to form and enlarge as the lower ones are harvested. In an early crop, the lower sprouts should be picked as soon as they are mature; otherwise, they will open out, go soft and yellow, then rot.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

For a once-over harvest, the plants should be topped, i.e., the growing point should be removed to prevent any further extension of growth and to encourage the maturity of the small sprouts at the top of the stem. Topping is normally done when the sprouts at the bottom of the stem are about 12 to 20 mm in diameter. In this way, a full stem of uniform marketable-sized sprouts will develop about 4 weeks later. Deleafing is necessary before a once-over harvest, but it should not precede harvesting by more than a day; otherwise, yield will be adversely affected.

DISEASE CONTROL

SEED DECAY, DAMPING-OFF, WIRESTEM, BLACK ROT, BLACKLEG, SOFT ROT, BACTERIAL LEAF SPOT OF CAULIFLOWER — Sow seed that has been hot-water treated and dusted with thiram or captan. Hot-water treatment (see page 26) is most important to help prevent black rot, blackleg, and bacterial leaf spot. For the control of black rot, as an alternative to hot-water treatment, treat the seed with streptomycin. Follow manufacturer's directions on the label. Field seedbeds should not be located downhill from where cabbage and related crops have been grown, and where residues of these crops will be blown by wind or spilled from passing trucks etc. To control disease-causing fungi and nematodes in seedbed soil, steam the soil or fumigate it with Vapam or Vorlex according to manufacturer's directions.

In the field follow, where possible, a 3-year rotation with unrelated crops whether the crop is transplanted or direct seeded. Avoid working among plants when they are wet. Do not irrigate with overhead sprinklers. In the fall or early spring, break up the crop refuse thoroughly and incorporate it into the soil.

YELLOWS — Use resistant cultivars (consult seed catalogue). If susceptible cultivars are grown, produce transplants in steamed or fumigated soil, and transplant to fields where yellows has not previously appeared.

CLUBROOT — Persists in soil at least 7 years. Use healthy transplants. Avoid infested and wet areas of fields. Where clubroot has been minor, sufficient control may be obtained by disking-in at least 1700 kg/ha of hydrated lime in the spring at least six weeks before planting, and applying sufficient agricultural limestone the previous year to give a pH of 7.2. Superfine limestone gives the quickest increase of the pH.

To test soil for clubroot, dig soil from various parts of the field, mix thoroughly, place in a container and sow Chinese cabbage. Examine the roots when seedlings are 8 cm tall. If any clubs are present, avoid planting cabbage and related crops in the tested field. Do not use hydrated lime on seedbeds. Fumigate seedbeds with Vorlex or Vapam if disease-free beds are not available (consult manufacturer's label directions).

Some field control is possible by using quintozene 75 (PCNB) in the transplant water at the rate of 1.5 kg in 200 L, applying at least 0.2 L per plant. This will be 3650 to 5600 L/ha. Provide good agitation. Do not use quintozene emulsion. No other method of applying quintozine is recommended.

DOWNY MILDEW — May appear in the seedbed or late in season. Downy mildew spreads rapidly in cool, wet weather. Under these conditions preventive spraying is recommended, as the following fungicides will only prevent new infections and not eradicate established lesions.

1. zineb 80 WP 2.25-3.25 kg (7 days)
2. tribasic fixed copper 4.5 kg (1 day) (fixed copper may be phytotoxic to cauliflower)
3. chlorothalanil 500 2.5-4.8 L or W-75 1.8-3.25 kg (7 days)

BLACK LEAF SPOT (Alternaria) — May be damaging in warm, wet seasons. Spray with one of the materials listed for downy mildew. Maneb 80% WP 2.25 to 3.25 kg (7 days) may be used only on cabbage.

Note: It is important to control downy mildew and black leaf spot on cabbage intended for prolonged storage (more than 3 months). Spray with maneb or chlorothalanil 2 or 3 times during the later part of the season.

NEMATODES — See page 25.

INSECT CONTROL

ROOT MAGGOTS

Seedbeds

For row spacings 30 cm and wider use [2]fensulfothion 720 SC 25 mL/10 L of water/100 metres of row in a 15-cm band over the row.

For row spacings less than 30 cm, do not apply more than 4.25 L per hectare. Do not repeat application.

Planting-water treatment

Use one of:

1. [2]azinphos-methyl 50% WP or 50 W 1 kg in 1000 L of water. Apply 200 mL per plant in transplant water. Repeat in 2 to 3 weeks.
2. [2]chlorfenvinphos 25% WP 1 kg in 1000 L of water (40 days). Apply 200 mL per plant in transplant water. Apply once only. Chlorfenvinphos may cause stunting of plants, especially in hot weather.

Treatment after Planting

Use one of:

1. [2]fensulfothion 720 SC 25 mL in 10 L of water per 100 metres of row for any row spacing in a 15-cm band over the row immediately after planting, e.g. for 75-cm row spacing, use 3.3 L/ha in 1000 L of water.
2. [2]azinphos-methyl 50% WP or 50 W 1 kg in 1000 L of water. Apply 200 mL per plant. Repeat in 2 to 3 weeks.
3. chlorpyrifos 4E 210 mL/130 L of water/100 metres of row. Apply in a 10-cm band on each side of the plant 3 days after transplanting. (not for Brussels sprouts)

Caution

— Do not use emulsifiable formulations in the planting water.

— Do not add fertilizer to planting water containing an insecticide unless recommended by the manufacturer or experience has proven the mixture to be safe.

Direct-seeded crops

Use [2]fensulfothion 720 SC 25 mL in 10 L water per 100 metres of row for any row spacing in a 15-cm band over the row immediately after planting, e.g. for 75-cm row spacing, use 3.3 L/ha in 1000 L of water.

FLEA BEETLE — Spray with one of:

1. endosulfan 4 EC 2 L or 400 EC 1.5-2 L (7 days)
2. carbaryl 50 W 2.25 kg or 85 W 1.75 kg (3 days)

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

CABBAGEWORM, CABBAGE LOOPER, DIAMONDBACK MOTH CATERPILLAR

Infestations of cabbageworm and diamondback moth caterpillar may begin early in the season, whereas cabbage loopers usually appear after mid July. Because the recommended insecticides are less effective against large larvae, check carefully for young larvae, beginning soon after planting. Begin application of insecticides when young larvae are found and continue at 5- to 10-day intervals, or as necessary for adequate protection of the crop.

To limit the development of resistance, **insecticides from one of the following groups must be used alternately with one from another group.** Use insecticides in Group B during the fall as they are more effective than the others under cool conditions.

Group A

1. *Bacillus thuringiensis*
   - — (Dipel) 16000 I.U. per mg, 0.75-1.1 kg
   - — **(Thuricide) 4000 I.U. per mg 2.25-4.5 L
   - — (Bactospeine-A) 8800 I.U. per mg, 0.6-2.3 L

   Use higher rates for looper control, heavy infestation or when foliage is dense (0 days).

Group B

1. permethrin 500 EC 70-140 mL or 384 EC 100-175 mL (3 days cabbage, cauliflower, Brussels sprouts; 7 days broccoli)
2. **fenvalerate 300 EC 70-140 mL (7 days cabbage; 14 days cauliflower, Brussels sprouts). Do not use on broccoli.
3. **deltamethrin 2.5 EC 300 -400 mL (3 days)
4. cypermethrin 250 EC, 140 mL/ha (3 days)

Group C

1. [1]methomyl L 2.25 L (1 day cabbage; 7 days cauliflower, broccoli, Brussels sprouts)
2. [2]methamidophos 480 1.1-2.25 L (7 days cabbage, cauliflower; 4 days broccoli, Brussels sprouts)
3. [1]mevinphos 200-275 mL (3 days)

Group D

1. endosulfan 4 EC 2 L or 400 EC 1.5-2 L (7 days)

APHIDS — Good coverage (bottom of leaves) is essential for aphid control. Spray with one of:

1. [2]demeton 240 SC 2 L (21 days)
2. dimethoate 480 E 0.75-1 L or 40 EC 0.85-1.25 L (4 days cabbage, cauliflower, broccoli; 21 days Brussels sprouts)
3. [2]oxydemeton-methly 240 SC 1.75-2.25 L (24 days cabbage, cauliflower, Brussels sprouts; 21 days broccoli). Use only once per season on broccoli.
4. [1]mevinphos 200-275 ml (3 days)
5. [2]methomyl 2.25 L (1 day cabbage; 7 days cauliflower, broccoli, Brussels sprouts)
6. [2]methamidophos 480 EC 1.1-2.25 L (7 days cabbage, cauliflower, 14 days broccoli, Brussels sprouts)

THRIPS — Dimethoate, as recommended for aphids, will give some control of thrips.

STORAGE

Late cabbage (Ballhead type) has a storage life of at least 3 to 4 months if held at 0°C with a relative humidity of 90% and good air circulation. Harvested heads should be trimmed at the base and dead or damaged leaves discarded. Avoid bruising during handling.

Pallet bins are commonly used for holding cabbage in storage. Heads may also be stored in bulk but require very careful piling to a depth of not over 1.5 m together with ample aeration of the pile with forced air. Pallet bins should be stored outside and subjected to the sun and light to control fungi, which develop on the wood and stain the cabbage.

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[1] *Minimum period before reentry is 24 hours.*

[2] *Minimum period before reentry is 48 hours.*

***See "Temporary Registration of Pesticides" inside front cover.*

CARROT

The carrot is a cool-season vegetable which is best adapted to areas of long, cool growing periods, free from extremes of temperature and moisture. The optimum mean temperature is between 16 and 21°C. High temperatures at the beginning of the growing season are injurious to the young plants. Continuous high temperatures in the latter stages of plant development may reduce yield, retard growth, and produce a strong-flavored, coarse root. Temperatures below 16°C will retard plant growth. The carrot is not tolerant to drought and so requires steady and relatively large amounts of moisture for optimum growth. Good rainfall distribution or irrigation throughout the growing season is necessary to prevent a check in growth.

CARROT (Continued)

CULTIVARS

Processing	**Packaging and Bunching**	**Use***
Camden *(trial)*	Candy Pak	1,2
Chantenay strains	Canuck	1,2
Danvers 126	Chancellor	1,2
Dess-Dan	Dominator	1
Royal Danvers	Gold Pak 28 and 263	1
Spartan Bonus	Grenadier	1,2
Spartan Bonus "80"	Hipak	1,2
Tahoe *(trial)*	Lance	1
	Orlando Gold	1,2
	Paramount	1,2
	Pioneer	1
	Six-Pak and Six-Pak II	1,2
	Spartan Classic	1,2
	Spartan Delight	1,2
	Spartan Fancy	1,2
	Spartan Premium	1,2
	Trophy	1,2

**Use: 1-Packaging 2-Bunching*

Note 1: The Spartan cultivars are also available in the "80" series.

Note 2: For cultivar susceptibility to rusty root, cavity spot, and horizontal lesions, see Disease Control.

CULTIVAR DESCRIPTIONS

Note: Cultivars are evaluated mostly on organic soils.

Camden — Danvers type with very good uniform internal color, high yield potential, smooth exterior.

Candy Pak — Long and slender, good yield, good quality and appearance.

Canuck — Excellent length and shape, good color and uniformity.

Chancellor — Long, good yielding, fairly uniform and smooth, tolerant to rusty root, blight and cavity spot, good color.

Chantenay strains — Medium length, broad shoulders tapering to blunt tips, strong tops.

Danvers 126 — More tapering and longer than most Chantenay types, fair to good internal color.

Dess-Dan — Long Danvers type with very small core and very good internal and external color.

Dominator — Long, good yield potential, partly Imperator type, suited for deep muck soils.

Gold Pak 28 and 263 — Imperator types with a narrow shoulder and relatively smooth skin, highly resistant to splitting, strong top, fair yields.

Grenadier — Uniform, long, highly adapted to deep muck soils.

Hipak — Very uniform size, shape and color, high yielding, long Nantes type with semi-blunt tip.

Lance — Long, good yielding, good color, resistant to rusty root, fairly smooth and uniform.

Orlando Gold — Long slender root, uniform shape and size, good exterior color.

Paramount — Very early, medium long, high yielding, tolerant to cavity spot, blight and rusty root, fairly good color.

Pioneer — High-yielding Nantes type, extremely uniform in size and type, medium long.

Royal Danvers — High-yielding long Danvers type with good color.

Six-Pak and Six-Pak II — Very long, very smooth and uniform, excellent color, good yielding, good resistance to cavity spot and rusty root, tolerant to blight. Six-Pak II has excellent resistance to cavity spot.

Spartan Bonus — Long Danvers type, very uniform, smooth, high yielding, outstanding internal color. Susceptible to seeders.

Spartan Bonus "80" — Similar to Spartan Bonus except it is not susceptible to seeders.

Spartan Classic — Danvers type, good color, good yield for early packaging and bunching, medium long, resistant to rusty root.

Spartan Delight — Long Imperator type, strong top, very good internal and external color, resistant to rusty root.

Spartan Fancy — Long Imperator type, strong top, very good internal and external color, resistant to rusty root, tops susceptible to blight.

Spartan Premium — Long Danvers type of medium length in the regular series, but longer in the "80" series, resistant to rusty root, tops susceptible to blight.

Tahoe — High-yielding Danvers type with very good internal color, a small core, and medium short tops.

Trophy — Uniform, very long, moderately pointed tip, excellent for deep muck soils.

SOIL

Deep, loose, fertile soils that have good water-holding capacity are necessary for the development of long, straight roots. Well-drained sandy loam, peat, or muck are ideal for carrot production.

SEEDING AND SPACING

TIME — As early as soil and weather conditions permit in the spring up to July 1. Late carrots may 'burn off' if they emerge during hot, dry weather.

RATE — Market: 2 to 4.5 kg/ha. Processing: 1 to 2 kg/ha.

DEPTH — 12 to 20 mm.

ROW SPACING — 40 to 60 cm depending on planting and harvesting machinery.

THINNING — Thin to 2.5 cm apart. Thinning is usually not necessary on muck soils.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22.)

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply up to 80 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16.)

APPLICATION — On MINERAL SOILS it is suggested to apply 2/3 of the nitrogen before planting and the balance side-dressed when plants are 10 cm tall. On MUCK SOILS broadcast up to 80 kg N/ha before planting. This is a maximum. Adjust the rate downward if tops have been too vigorous in previous years.

MICRONUTRIENTS — BORON deficiency can cause necrosis in the growing tip or internal breakdown in carrot roots. Boron is recommended on new muck soils. Boron is applied mixed with the fertilizer at 2-6 kg boron/ha. Various sources of boron are available.

PESTICIDE NAMES

Refer to this section for a cross reference of brand names and common names of pesticides recommended in this publication. The centerfold section may be removed, if desired, for easier reference.

PESTICIDE NAMES

b - bactericide
i - insecticide
f - fungicide
( ) Schedule (see below)
m - miticide
n - nematicide
h - herbicide
g - growth regulator

Common Names			Brand Names
aldicarb	(5)	i	Temik
anilazine	(3)	f	Dyrene
azinphos-methyl	(5)	i	Guthion, APM
Bacillus thuringiensis	(3)	i	Thuricide, Dipel, Bactospeine-A
benomyl	(3)	f	Benlate
captan	(2)	f	Orthocide
carbaryl	(3)	im	Sevin
carbofuran	(5)	i	Furadan
carbathiin + thiram	(3)	f	Pro-Gro
chlordane	(2)	i	chlordane
chlorfenvinfos	(5)	i	Birlane
chloropicrin, 1, 3 dichloro-propene	(2)	ifn	Telone C-17
chlorothalanil	(3)	f	Bravo
chlorpyrifos	(2)	i	Lorsban
copper hydroxide	(3)	bf	Kocide 101
cypermethrin	(5)	i	Cymbush
dazomet	(2)	ifnh	Soil Kare (Mylone), Basamid
deltamethrin	(5)	i	Decis
demeton	(5)	im	Systox
diazinon	(2)	i	Basudin, Diazol
1, 3-dichloropropene	(2)	ifn	Telone II
1, 3 dichloropropene/methyl isothiocyanate mixture	(2)	bifnh	Vorlex Plus
1, 3 dichloropropene + chloropicrin	(2)	n	Telone C-17
dichloran		f	Botran
dicofol	(2)	m	Kelthane
dimethoate	(2)	im	Cygon, Dimethoate 40
dinoseb	(2)	h	Dytop, Topper, Potato Top Killer
diquat	(3)	h	Reglone
disulfoton	(5)	im	Di-Syston
endosulfan	(2)	i	Thiodan, Endosulfan, Thionex
fensulfothion	(5)	i	Dasanit
fenvalerate	(2)	i	Belmark
ferbam	(3)	f	ferbam
fixed copper	(3)	bf	Basi-cop, Spraycop, Tri-cop, Kocide, etc.

Common Names			Brand Names
fonofos	(5)	i	Dyfonate
formaldehyde		f	formalin
iprodione	(3)	f	Rovral
lindane	(2)	i	lindane
maleic hydrazide		g	Royal MH 60 SG
malathion	(3)	im	malathion
mancozeb	(3)	f	Dithane M-45, Manzate 200
maneb	(3)	f	Dithane M22, Manzate D, Mantox
metalaxyl	(2)	f	Ridomil
metam-sodium	(3)	bifnh	Vapam
methamidophos	(5)	i	Monitor
methidathion	(5)	i	Supracide
methomyl	(2)	i	Lannate
methoxychlor	(3)	i	Marlate, Moxy
methyl bromide	(1)	ifnh	MB-C_2
metiram	(3)	f	Polyram
mevinphos	(5)	im	Phosdrin
methyl isothiocyanate/1,3 dichloro-propene	(2)	ibfnh	Vorlex Plus
naled	(2)	i	Dibrom, Bromex
oxamyl	(5)	i	Vydate
oxine benzoate	(3)	f	No-Damp
oxydemeton-methyl	(2)	im	Metasystox-R
parathion	(5)	im	parathion
permethrin	(3)	i	Ambush, Pounce
phorate	(2)	i	Thimet
phosmet	(3)	i	Imidan
piperonyl butoxide		i	piperonyl butoxide
pirimicarb	(2)	i	Pirimor
quintozene (PCNB)	(3)	f	Terraclor
rotenone	(3)	i	rotenone
streptomycin	(3)		Agri-Mycin 17
thiophanate-methyl	(3)	f	Easout
thiram	(3)	f	thiram
zineb	(3)	f	Thiogreen
ziram	(3)	f	ziram

The numbers within the brackets ( ) identify the Schedules in which the BRAND NAME products listed in this Section are classified under the Pesticides Act.

Explanation of Schedules:

Schedule 1 Restricted. Use permit only.
Schedule 2 Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3 May be available for "Domestic" purposes if so registered.
Schedule 4 "Domestic" products only.
Schedule 5 Limited to application on agricultural land.
Schedule 6 Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of the Environment office nearest you. (See page 66).

PESTICIDE NAMES (Continued)

b - bactericide
i - insecticide
f - fungicide
( ) Schedule (see opposite page)
m - miticide
n - nematicide
h - herbicide
g - growth regulator

Brand Names			Common Names
Agri-Mycin 17	(3)		streptomycin
Ambush, Pounce	(3)	i	permethrin
APM	(5)	i	azinphos-methyl
Bactospeine-A, Dipel, Thuricide	(3)	i	*Bacillus thuringiensis*
Basamid, Soil Kare (Mylone)	(2)	ifnh	dazomet
Basi-Cop, Spraycop, Tri-cop, Kocide, etc.	(3)	bf	fixed copper
Basudin, Diazol	(2)	i	diazinon
Belmark	(2)	i	fenvalerate
Benlate	(3)	f	benomyl
Birlane	(5)	i	chlorfenvinfos
Botran		f	dichloran
Bravo	(3)	f	chlorothalanil
Bromex, Dibrom	(2)	i	naled
Cygon, Dimethoate 40	(2)	im	dimethoate
Cymbush	(5)	i	cypermethrin
Dasanit	(5)	in	fensulfothion
Decis	(5)	i	deltamethrin
Diazol, Basudin	(2)	i	diazinon
Dipel, Bastospeine A, Thuricide	(3)	i	*Bacillus thuringiensis*
Dibrom, Bromex	(2)	i	naled
Difolatan	(2)	f	captafol
Dimethoate 40, Cygon	(2)	im	dimethoate
Di-Syston	(5)	im	disulfoton
Dithane M-22, Mantox Manzate D	(3)	f	maneb
Dithane M-45, Manzate 200	(3)	f	mancozeb
Dyfonate	(5)	i	fonofos
Dyrene	(3)	f	anilazine
Dytop, Topper, Potato Top Killer	(2)	h	dinoseb
Easout	(3)	f	thiophanate-methyl
Endosulfan, Thiodan, Thionex	(2)	i	endosulfan
ethion	(2)	i	ethion
Furadan	(5)	i	carbofuran
Guthion	(5)	i	azinphos-methyl
Imidan	(3)	i	phosmet
Kelthane	(2)	m	dicofol
Kocide 101	(3)	bf	copper hydroxide
Kocide, Tri-cop, Basi-cop, Spraycop	(3)	bf	fixed copper
Lannate	(2)	i	methomyl
Lorsban	(2)	i	chlorpyrifos
Mantox, Dithane M22, Manzate D	(3)	f	maneb
Manzate D, Mantox, Dithane M22	(3)	f	maneb
Manzate 200, Dithane M45	(3)	f	mancozeb
Marlate, Moxy	(3)	i	methoxychlor
MB-C$_2$	(1)	ifnh	methyl bromide + 2% chloropicrin
Metasystox-R	(2)	im	oxydemeton-methyl
Monitor	(5)	i	methamidophos
Moxy, Marlate	(3)	i	methoxychlor
Mylone (Soil Kare), Basamid	(3)	ifnh	dazomet
No-Damp	(3)	f	oxine benzoate
Orthocide	(2)	f	captan
Phosdrin	(5)	im	mevinphos
Pirimor	(2)	i	pirimicarb
Polyram	(3)	f	metiram
Potato Top Killer, Topper, Dytop	(3)	h	dinoseb
Pounce, Ambush	(3)	i	permethrin
Pro-Gro	(3)	f	carbathiin + thiram
Reglone	(3)	h	diquat
Ridomil	(2)	f	metalaxyl
Rovral	(3)	f	iprodione
Royal MH 60 SG	(3)	g	maleic hydrazide
Sevin	(3)	i	carbaryl
Soil Kare (Mylone), Basamid	(2)	ifnh	dazomet
Spraycop, Basi-cop, Tri-cop, Kocide, etc	(3)	bf	fixed copper
Supracide	(5)	i	methidathion
Systox	(5)	im	demeton
Telone II	(2)	ifn	1, 3 dichloropropene
Telone C-17	(2)	n	1, 3 dichloropropene + chloropicrin
Temik	(5)	i	aldicarb
Terraclor	(3)	f	quintozene (PCNB)
Thimet	(2)	i	phorate
Thiodan, Endosulfan, Thionex	(2)	i	endosulfan
Thiogreen	(3)	f	zineb
Thionex, Thiodan. Endosulfan	(2)	i	endosulfan
Topper, Dytop, Potato Top Killer	(2)	h	dinoseb
Thuricide, Dipel, Bastospeine-A	(3)	i	*Bacillus thuringiensis*
Tri-cop, Basi-cop, Spraycop, Kocide, etc.	(3)	i	fixed copper
Vapam	(3)	bifnh	metam-sodium
Vorlex Plus	(2)	bifnh	1, 3-dichloropropene/methyl isothiocyanate mixture
Vydate	(5)	i	oxamyl

CARROT (Continued)

COPPER deficiency may occur on acid peat and muck soils. It results in poor orange color development in the carrot roots. Apply 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

DISEASE CONTROL

SEED DECAY, DAMPING-OFF — Planting carrot seed treated with thiram has resulted in improved stands.

ASTER YELLOWS — See Leafhoppers (Insect Control section).

LEAF SPOTS, BLIGHT — Apply about 5 sprays, starting in late July, using one of:

1. maneb 80% WP 3.25 kg (5 days)
2. mancozeb 80% WP 2.25 kg (7 days)
3. zineb 80% WP 3.25 kg (7 days)
4. chlorothalanil 500 2.4-3.2 L (1 day)

An alternative weather-timed spray program is available in the Bradford area. In this program, fungicide sprays are applied according to the following rules: (1) No fungicide is applied until blight appears on 1 to 2% of the leaf area. This coincides roughly with the time when blight is first detectable. (2) After this time, apply a recommended fungicide at 7- to 10-day intervals when weather is favorable for blight; extend the interval between sprays when the weather is unfavorable for blight. Lack of rainfall or cool nights (minimum temperature less than 15°C) are unfavorable for blight.

For further information, see OMAF Factsheet, *Weather-Timed Sprays for Carrot Blight Control,* Agdex 258/635, and consult your Pest Management Specialist regarding blight assessments and blight-favorable weather.

SCLEROTINIA MOLD (of carrots, lettuce, beans and celery) — Rotate with onions, beets or spinach for 2 to 3 years. Use row spacings to encourage good air movement.

NEMATODES — See page 25.

RUSTY ROOT — Follow a 3-year rotation with unrelated crops, e.g. onions. Avoid known severely infested fields. Sow seed after the soil has warmed up in the spring. Use disease-resistant cultivars, e.g. Grenadier and Spartan hybrids (see Cultivar Descriptions). Avoid heavy plant stands; obtain uniformly-spaced plant populations with precision-seeding equipment.

VIOLET ROOT ROT — Since the fungus causing this disease persists for several years and affects primarily carrots, the best control is to rotate with other crops, e.g. onions or crucifers.

CAVITY SPOT, HORIZONTAL LESIONS — These disorders have been found on the main taproot of carrots grown on organic soils in Ontario. Research has shown that cultivars differ in susceptibility. Select cultivars which are least susceptible (consult the Annual Vegetable Cultivar Trials and Research Report published by the Muck Research Station). Do not over-fertilize. Before seeding get a soil test (see page 14).

INSECT CONTROL

LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Apply 3 sprays at 10-day intervals in July and early August or starting as soon as aster leafhoppers appear. Also control weeds in headlands, ditchbanks, roadsides etc. and control leafhoppers on adjacent celery and lettuce.

Spray with one of:

1. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (1 day)
2. [3]parathion 15% WP 2.25 kg (15 days)

Rapid killing is obtained using parathion; slower but more lasting control is obtained with carbaryl.

CARROT RUST FLY

This insect is mainly a problem in the Bradford and district Marshes. Growers in other areas should consult their Pest Management Specialist before initiating a routine spray program.

The carrot rust fly is monitored throughout the growing season in the Bradford area. Consult your Pest Management Specialist for information on participating in the program or for up-to-date information on timing of sprays. The first generation of flies is normally present from late May until late June, the second generation from late July until September.

Spray when recommended with one of:

1. diazinon 50% WP 1.1 kg or 500 EC 1.1 L (10 days)
2. [3]parathion 15% WP 2.25 kg (15 days)

When flies are abundant, these sprays may not prevent damage to carrots growing adjacent to sheltered areas.

Cultural practices

Carrots seeded after June 1 are rarely attacked by the first generation of the carrot rust fly. Carrots harvested by early September should escape most second generation damage. If possible, avoid growing carrots immediately adjacent to sheltered areas (e.g. the canal banks of the Holland Marsh).

CARROT WEEVIL — Spray with phosmet 50% WP 2.25 kg (40 days) when carrots are in the first true-leaf stage. Repeat once 10 to 14 days later. Do not apply more than two times per season or later than 40 days before harvest. Spraying with phosmet may also reduce the carrot rust fly population.

SPROUT INHIBITION AND STORAGE

To inhibit sprouting in storage, apply maleic hydrazide about four to six weeks before harvest according to manufacturer's recommendations. Apply to healthy plants only.

Mature topped carrots can be stored for up to 4 to 5 months at 0°C and a relative humidity of 90 to 95%.

Storage rots occur from infections of the carrot through wounds. Proper sanitation of the storage and handling equipment is necessary to help reduce infections. The addition of a fungicide to a dip or spray before or during the storage period will help to prevent these infections. Spray or dip **washed carrots** with a suspension of 500 g to 1 kg benomyl per 1000 L water before or during the storage period. Carrots for export cannot be treated as they may be refused entry to other countries.

Carrots already infected will not benefit from this treatment.

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[3] *Minimum period before reentry is 7 days.*

CELERY

CULTIVARS

Main Crop (green)

Clean-cut
Florida 2-14
Florida 683
Surepak
Tendercrisp
Utah 52-70 strains
Ventura (*trial*) — tolerant to bolting

SEED TREATMENT

Buy hot-water-treated seed or sow three-year-old seed to avoid seed-borne blight fungi. Treat seed before sowing with a protectant such as thiram, following manufacturer's directions.

GROWING TRANSPLANTS

Sow seed 10 to 12 weeks before field planting. About 140 grams of seed provide enough plants for one hectare when the standard field spacing is used.

Until the plants emerge, a temperature of 21 to 24°C is suitable. Then 18 to 24°C is ample for steady growth. Night temperatures should not drop below 13°C to lessen the production of "seeders".

Plants for the early crop should not be set in the field until the danger of a prolonged cool period or actual freezing is over.

If the plants have become too tall and spindly before field setting they can be clipped back to a height of 12 to 15 cm.

Clipped plants facilitate transplanting but well-grown, untrimmed plants are preferable because they receive less check in growth.

Plants for the late crop may be started in outdoor seedling beds if water is available for irrigation. The seed may be sown with a seed drill in rows 15 to 20 cm apart, at the rate of 80 to 110 seeds per metre of row so that the stand will not need thinning before transplanting to the field. Or, seed may be broadcast in a finely prepared bed outdoors at the rate of 15 grams per 10 m^2. However, the first method provides sturdier plants.

PREMATURE SEEDSTALK DEVELOPMENT

The development of flowering shoots, or "bolting to seed", instead of the normal growth, is mainly due to exposure of young plants to temperatures below 13°C for 10 days or more.

The amount of bolting increases as the time of exposure is lengthened. Growers producing plants, especially for the early crop, should maintain greenhouse temperatures of 16 to 21°C. The plants can be hardened, if so desired, by withholding water the last 7 to 10 days before setting in the field. Do not harden-off celery plants by lowering temperatures.

SPACING

The standard spacing is 15 cm apart in rows 80 to 85 cm apart.

Celery can be direct seeded at a rate of 1 kg per ha. Thin plants to 15 cm apart in the row.

SOIL

Muck soil is ideal for celery production because of its high moisture-holding capacity. Celery may be grown successfully on well-drained mineral soil such as a sand-loam, but irrigation may be necessary under upland conditions. Rotation with other crops is an important aid in the control of diseases and insects.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — On MINERAL SOILS apply 195 kg N/ha. On MUCK SOILS apply up to 170 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — Apply 2/3 of the nitrogen at planting time and the remainder sidedressed in 2 or 3 applications as required.

SECONDARY AND MICRONUTRIENTS — CALCIUM deficiency results in a physiological disorder known as "black heart", in which the celery heart turns black while the outer leaves are unaffected.

Spray directly into the heart of the plant with 2.2-4.0 kg calcium from calcium chloride or 1.2-3.4 kg calcium from calcium nitrate per 1000 L water. If celery is under moisture stress, reapply once a week.

MAGNESIUM deficiency appears as chlorosis between the dark green veins of the older leaves. Some celery cultivars are inefficient in taking up magnesium from the soil. Apply a foliar spray of magnesium sulfate at rates supplying 1.0-1.6 kg magnesium per 1000 L water every 10-14 days starting when the plants are about 1/3 grown.

BORON deficiency results in a physiological disease known as "cracked stem" or "cat scratches". Apply 1-3 kg boron/ha (2-6 kg/ha on muck soils) with the fertilizer, and a foliar spray of 0.2-0.6 kg boron per 1000 L water. Spray when the young plants are about 15 cm tall. A second spray application may be required.

DISEASE CONTROL

EARLY BLIGHT, LATE BLIGHT — Sterilize soil for growing seedlings in flats or frames. Rotate outdoor seedbeds. Use three-year-old or hot-water-treated seed. Start spraying or dusting when seedlings are about 5 cm high and repeat weekly throughout season. Spray with one of:

1. maneb 80% WP 2.25 kg (14 days)
2. mancozeb 80% WP 2.25 kg (7 days)
3. anilazine 50% WP 2.25-3.25 kg (1 day, wash and trim)
4. metiram 80 W 2.25 kg after transplanting (7 days)
5. zineb 80 WP 3.25 kg (14 days)
6. fixed copper 2.25 kg active ingredient (1 day)
7. chlorothalanil 500 1.6-2.4 L on a 3- to 5-day schedule or 2.4-4 L on an 8- to 10-day schedule (7 days)

Dust: metiram 7% 34-45 kg (7 days)

ASTER YELLOWS — See Leafhoppers (Insect Control Section).

CUCUMBER MOSAIC VIRUS — Control weeds bordering the crop area. Weeds are the source from which aphids bring in the mosaic virus. Rogue out plants if mosaic infection is noticed early in the season. Keeping aphids under control may reduce spread of the virus.

NEMATODES — See page 25.

INSECT CONTROL

Consult the label before combining any insecticide with fixed copper.

LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Apply three sprays at 10-day intervals in July and early August. Also control weeds in headlands, ditchbanks, roadsides etc. and control leafhoppers on adjacent carrots and lettuce.

CELERY (Continued)

Spray with one of:

1. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (3 days)
2. [3]parathion 15% WP 2.25 kg or 800 E 275-400 mL (21 days). **To avoid excessive residues, do not use parathion more than twice during the growing period.**
3. malathion 25% WP 4.5 kg (7 days)
4. [1]mevinphos 450 mL (3 days)
5. cypermethrin 250 EC 140 mL (7 days)

TARNISHED PLANT BUG — Spray with one of the materials listed for Leafhopper control, or use endosulfan 50% WP 1.75 kg or 4 EC 2 L or 400 EC 2 L. Trim the celery (14 days).

APHIDS — Spray with one of:

1. naled 8.64 EC 1.7 L or 65.4 EC 1-1.5 L (4 days)
2. endosulfan 50% WP 1.75 kg or 4 EC 2 L or 400 EC 2 L. Trim the celery. (14 days)
3. [2]demeton 240 SC 1.25 L (28 days)
4. [1]mevinphos 450 mL (3 days)

Note: *The green peach aphid is becoming resistant to these insecticides in some areas.*

CABBAGE LOOPER — Spray when loopers first appear with one of:

1. ***Bacillus thuringiensis* 4.5 L or 1.1 kg (0 days)
2. endosulfan 50% WP 1.75 kg or 4 EC 2 L or 400 EC 2 L. Trim the celery. (14 days)
3. [1]mevinphos 450 mL (3 days)

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[1] *Minimum period before reentry is 24 hours.*

[2] *Minimum period before reentry is 48 hours.*

[3] *Minimum period before reentry is 7 days.*

***See "Temporary Registration of Pesticides" inside front cover.*

STORAGE

Celery badly damaged by frost, disease, or handling should not be stored. A relative humidity of 95 to 98% and a temperature of 0°C are ideal. Celery should be stored in a room that is free from odors because the plant absorbs foreign flavors. Field heat should be removed, by hydro cooling or vacuum cooling, before placing in large storage rooms.

CORN (SWEET)

CULTIVARS

(not revised for 1986)

Listed in order of maturity

SHIPPING	ROADSIDE AND HOME GARDEN
Earlivee	Polarvee
Buttervee	Earlivee
Beacon	Buttervee
Seneca Horizon (*trial*)	Seneca Horizon (*trial*)
Sundance	Goldenvee
Goldenvee	Early Gold and Silver (bicolor)
Miracle (*trial*)	Tablevee
Jubilee	Platinum Lady (white)
Flavorvee	Burgundy Delight (bicolor)
Stylepak	Tastyvee
	Miracle (*trial*)
	Jubilee
	White Lightning (white)
	Sweet Sal (bicolor)
	Flavorvee
	Silver Queen (white)
	Biqueen (bicolor)

PROCESSING — as required by processors

CULTIVAR DESCRIPTIONS

Days-to-maturity and corn heat units (CHU) as given below are based on data obtained at Simcoe following planting about May 16.

Reaction to head smut (*Spacelotheca reiliana*) is given only for those cultivars that have been tested in controlled experiments.

Beacon — 78 days, 1650 CHU, 12-60 rows, good quality and appearance, excellent husk color.

Biqueen — 104 days, 2250 CHU, 12-16 rows, good quality and appearance, excellent husk color, bicolor, some resistance to head smut.

Burgundy Delight — 90 days, 1950 CHU, 12-14 rows, excellent appearance and quality, purple husks, bicolor, susceptible to head smut.

Buttervee — 77 days, 1600 CHU, 10-14 rows, attractive, high quality, short tip cover, pale yellow kernels, some resistance to head smut.

Earlivee — 76 days, 1600 CHU, 12-14 rows, good appearance and quality, good tip cover, some resistance to head smut. Less successful in Eastern Ontario.

Early Gold and Silver — 86 days, 1850 CHU, 12 rows, good appearance and quality, purple husks, bicolor.

Flavorvee — 96 days, 2150 CHU, 14-18 rows, excellent appearance and quality, exceptional holding quality, excellent for freezing, some resistance to head smut.

Goldenvee — 83 days, 1800 CHU, 12-16 rows, good husk color, excellent tip cover, not as good tip filling as Sundance, but much higher eating quality, susceptible to head smut.

Jubilee — 94 days, 2050 CHU, 16-20 rows, good quality, large attractive ear, hard to snap, rather poor tip cover.

Miracle — 90 days, 1950 CHU, 16-18 rows, exceptional eating quality, good appearance and tip cover, contains the sugar enhancer (se) gene.

Miracle is one example of the new breed of "augmented sugar level" sweet corn cultivars. It contains its high sugar level from the sugar enhancer gene (se). These new cultivars express their high sugar levels best when grown in isolation. This isolation can be obtained by planting them between cultivars that tassel at different times than the "augmented sugar level" cultivars.

CORN (SWEET) (Continued)

Platinum Lady — 89 days, 1900 CHU, 12-16 rows, good appearance, excellent quality, purple husks, white, susceptible to head smut.

Polarvee — 73 days, 1500 CHU, 12-14 rows, good flavor but rather tough, short ear, very poor appearance, useful only for its exceptional earliness.

Seneca Horizon — 78 days, 1650 CHU, 14-16 rows, good quality, good appearance and tip cover.

Silver Queen — 104 days, 2200 CHU, 14-16 rows, excellent appearance and good quality, white, some resistance to head smut.

Stylepak — 96 days, 2100 CHU, 16-22 rows, good quality, good tip cover, susceptible to rust, some resistance to head smut.

Sundance — 82 days, 1750 CHU, 12-16 rows, average eating quality, excellent appearance, good tip cover.

Sweet Sal — 93 days, 2050 CHU, 14-18 rows, excellent appearance, fair quality, good tip cover, bicolor.

Tablevee — 89 days, 1900 CHU, 12-16 rows, excellent eating quality, fairly good appearance, good tip cover, excellent for freezing, good resistance to head smut.

Tastyvee — 90 days, 1950 CHU, 12-14 rows, exceptionally high quality but rather poor unhusked appearance, rather small ear, many suckers, outstanding for freezing.

White Lightning — 93 days, 2050 CHU, 12-16 rows, very good appearance and quality, white, some resistance to head smut.

SCHEDULED PLANTING

Day-to-maturity vary according to the temperature. The same cultivar may require 85 days to reach maturity if planted in early May but only 65 days if planted in mid-June. It will also mature later in cooler regions of the province. However, it will require approximately the same number of Corn Heat Units (CHU). To assure a regular supply of sweet corn, corn should be seeded according to the accumulated-CHU system. CHU ratings should be adjusted for plantings made in warm soil (e.g. after June 1) by subtracting a correction factor of 100 from the given rating.

SEEDING AND SPACING

Eleven to seventeen kilograms of seed are required to plant one hectare depending on seed size. Where small seed is used the lower amount is sufficient. Optimum soil temperature for germination is from 18 to 29°C.

EARLY CULTIVARS — Rows as close as 75 cm, plants 20 to 22 cm apart.

TALL, LATE CULTIVARS — Rows 95 cm apart, plants 22 to 25 cm apart.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — 90 kg N/ha is recommended. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16.)

APPLICATION — A portion of the nitrogen and phosphorus required should be applied at seeding in one of two ways:

1. In a band 5 cm to the side and 5 cm below the seed. The rate of application in the band should not supply more that 75 kg nitrogen/ha or a total of 120 kg of nitrogen plus potash (K_2O) per hectare in 75-cm rows. If urea is the nitrogen source, not more than 40 kg nitrogen or 80 kg of nitrogen plus potash/ha should be applied, in 75-cm rows.
2. In a band directly with the seed. With this placement, not more than 9 kg nitrogen plus potash (K_2O)/ha should be applied, in 75-cm rows. A major portion of the nitrogen should be applied pre-plant or side-dressed before the corn is 30 cm high. A major portion of the phosphate and potash may be broadcast and worked in either in the fall or before seeding in the spring.

MICRONUTRIENTS — ZINC deficiency occurs occasionally in corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful.

Where zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 12 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at seeding. Zinc may be applied as a spray at rates supplying 0.6 kg zinc/1000 litres of water. A wetting agent should be added.

BIRD AND ANIMAL CONTROL

RED-WINGED BLACKBIRDS AND CROWS — Acetylene exploders are effective but birds will soon resume feeding when exploders are not operating. For full effectiveness locate them above the cornstalks, and move them around frequently. Constant patrolling and shooting during morning and evening feeding periods is effective but expensive. Plant away from marshy and wooded areas. Cultivars with ears well covered by husks are somewhat resistant to blackbirds.

Av-Alarm electronic bird-scaring devices have sometimes been used successfully to repel large flocks of birds from fields of sweet corn.

RACCOONS AND SKUNKS — Shoot or trap in season. Plant the crop away from wooded areas. An electric fence with three strands placed at 8- to 10-cm intervals from the ground has given satisfactory control.

DISEASE CONTROL

SEED DECAY — Treat seed with thiram or captan seed protectant.

LEAF BLIGHTS, STALK ROTS, EAR ROTS — Rotate corn with unrelated crops such as peas, carrots, potatoes, beans and tomatoes. Plow under old cornstalks and leaves. Maintain well-balanced soil fertility.

COMMON SMUT — Crop rotation (4 years) may be helpful. Plant sweet corn following a legume such as alfalfa, clover, or beans. Do not plant sweet corn after field corn.

HEAD SMUT — This disease was first found in Ontario in 1979 and is easily confused with common smut. Follow recommendations given for common smut. The head-smut fungus survives in soil for several years. For detailed information, consult OMAF Factsheet, *Head Smut of Corn,* Agdex 111/632. See also Cultivar Descriptions.

CORN (SWEET) (Continued)

INSECT CONTROL

SEED MAGGOTS AND WIREWORMS — Treat seed with diazinon, lindane and a fungicide. See Chemical Seed Treatment, page 26.

EUROPEAN CORN BORER — Apply sprays at 5-day intervals when egg masses begin to hatch (e.g. about mid-June in Essex County), but no later than when first pinhole feeding is seen on the leaves. Spray should be directed into whorl of plant. After tassels appear, direct spray at ear zone.

For second-brood borers, late plantings should be treated before tassels shows in the whorl. Repeat at **5-day intervals** through the green-tassel and early-silk stages. Keep the ear zone well protected.

Spray with one of:

1. permethrin 500 EC 200-275 mL or 384 EC 275-375 mL (1 day)
2. cypermethrin 250 EC 280 mL (7 days)
3. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (1 day)
4. [2]carbofuran 480 F 1.1 L (7 days)
5. [1]methomyl L 2.6 L (3 days)
6. [3]parathion 15% WP 4.5 kg or 800 E 850 mL (12 days)

Good control, especially of second-brood borers, will require 4 or more treatments, at **5-day intervals.** Call the Agriphone number (page 2) or the Pest Management Specialist or Crop Advisor in your area for timing of sprays.

FALL ARMYWORM — Effective controls have been obtained with treatments applied for corn earworm.

CORN EARWORM — Apply 4 sprays at 4-day intervals (3-day intervals in hot weather), starting when 25% of ears show silk. Direct spray on silks, using one of:

1. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (1 day)
2. permethrin 500 EC 200-275 mL or 384 EC 275-375 mL (1 day)
3. [1]methomyl L 1.8-2.6 L (3 days)

CORN ROOTWORM — Where corn rootworm has been a problem, crop rotation is recommended.

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[1] *Minimum period before reentry is 24 hours.*
[2] *Minimum period before reentry is 48 hours.*
[3] *Minimum period before reentry is 7 days.*

Bee Warning

Bees often visit sweet and field corn to collect pollen. Where spraying is being done, bee poisoning may result. **Carbaryl, carbofuran and permethrin are highly toxic to bees** but **carbaryl** is the most damaging since it is carried to the hive and poisons the brood. If bees are in the area advise local beekeepers of spraying activity and do not use carbaryl. Your local Agricultural Representative has a list of beekeepers in your area. Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid spray drift to roadsides and adjacent fields where plants may be in bloom.

CEREAL LEAF BEETLE

The presence of this insect throughout Southern Ontario has made necessary the enforecement of certain regulations to prevent the spread of this pest. Growers contemplating the sale of small grains, shelled or ear corn, hay and straw, to buyers north of a line from Wawa east on Highway 101 through Matheson to the Quebec border should inquire at an office of the Plant Quarantine Division (Agriculture Canada) in Windsor, London, Niagara Falls, Toronto or Ottawa.

Watch for and report damage by this insect in oats, wheat and barley to your OMAF county extension office.

CUCUMBER (FRESH MARKET), MUSKMELON, WATERMELON, PUMPKIN AND SQUASH

VINE-CROP CULTIVARS

CUCUMBER (listed alphabetically)

Dasher II
Highmark II
Marketmore 76
Medalist
Raider
Southern Set
Slicemaster
Sprint 440

MUSKMELON

Harper Hybrid
Burpee Hybrid
Market Star
Delicious 51
Gold Star
Samson[1]
Luscious
Main Rock
Canada Gem Hybrid
Saticoy Hybrid[1]
Roadside
Summet[1]
Supermarket[1]

WATERMELON

Dixie Lee
Sugar Baby
Crimson Sweet
Blue Belle (*trial*)
Long-Oblong for long-season areas
Royal Jubilee
Charleston Gray 113
Royal Sweet
Prince Charles

PUMPKIN

Cinderella (bush)
Connecticut Field
Small Sugar (home use)
Jackpot Hybrid (Halloween)
Spooky (semi-bush, home use)
Early Cheyenne Pie (home use in northern areas)

SQUASH (WINTER)

Waltham Butternut
Hercules
Kindred
Buttercup
Royal Acorn
Hubbard (Golden, Blue, Green)
Delicious
Boston Marrow

SQUASH (SUMMER)

Cocozelle
White Bush Scallop
Zucchini Elite

[1] *Resistant to powdery mildew*

SEED TREATMENT

Treat seed with a fungicide such as thiram or captan according to the manufacturer's directions.

PLANTING MELONS

Early muskmelon crops are usually started in hotbeds or greenhouses five weeks before transplanting outdoors.

About three seeds are sown 2.5 cm deep in sterile soil in 10 x 10-cm bands, or 10-cm clay, plastic or peat pots. Seedlings are thinned to two per pot.

Germination temperature should be 27 to 29°C until seedling emergence, then 16 to 18°C minimum night temperature.

The plants should be set in the field with a starter solution.

Watermelons may be treated in a similar manner.

MULCHING MELONS

Mulching melon transplants or seeding directly through mulches of black polyethylene or plastic-coated paper has proven beneficial because of an increase in early and total yield. These mulches also conserve moisture, control weeds, accelerate maturity by increasing soil temperature, and reduce fruit rots.

The polyethylene films are usually black or some other dark color in order to control weeds. If a clear film is used, a preemergence herbicide must be incorporated into the soil before laying the mulch. Mulching materials are usually 1.5 mil thick and usually come in 90- or 120-cm-wide rolls. A tractor-mounted machine lays the mulch and covers the edges with soil. If the rows are 1.9 m to 2.2 m apart, 2,200 m or 1,900 m respectively, are required.

Commercial machines are available to transplant plants in peat pots through the mulch. There are also seeders that can plant through the mulch.

The use of photo-degradable mulches that disintegrate in the presence of light eliminates the need for removing the mulch from the soil after harvest.

SEEDING AND SPACING

About 2.2 kg of seed are required to produce enough cucumber and muskmelon transplants for one hectare. For direct seeding of cucumbers and melons 4.5 to 5. 5 kg of seed per hectare are required.

Squash and pumpkin seeding rates vary somewhat with seed size. Large-seeded cultivars such as Blue Hubbard will require 3.5 to 4.5 kg per hectare and small-seeded cultivars such as Butternut 1 to 1.5 kg per hectare.

CUCUMBER — Rows 1.2 to 1.8 m, plants 3 cm apart.

MUSKMELON — Rows 1.5 to 1.8 m, plants 60 to 120 cm apart.

WATERMELON — Rows 1.8 to 2.5 m, plants 90 to 120 cm apart.

PUMPKIN (STANDARD) AND WINTER SQUASH — Rows 1.8 to 2.5 m, plants 90 to 120 cm apart.

PUMPKIN (BUSH) AND SUMMER SQUASH — Rows 90 to 120 cm, plants 60 top 90 cm apart.

POLLINATION

All the vine crops depend on insects to transfer pollen from the male to the female blossoms, which are borne separately on the same plant. In small plantings there may be sufficient native pollinating insects to perform this service. In large plantings, the grower would be well advised to introduce one colony of honeybees for every hectare to ensure adequate pollination. Insecticides will poison bee. See warning on page 43 re bee poisoning.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to 110 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

CUCUMBER (FRESH MARKET) MUSKMELON, WATERMELON, PUMPKIN AND SQUASH (Continued)

APPLICATION — Broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. Alternatively, up to 100 kg of $(N + K_2O)$/ha can be applied in a band, 5 cm to the side and 5 cm below the seed at planting with the remainder of the fertilizer broadcast before planting.

The remainder of the N should be side-dressed before the vines begin to run, and on sandy soils a second application may be necessary after the vines begin to run, especially following heavy rains.

IRRIGATION — If the nitrogen is applied through the irrigation system, no more than 20 kg N/ha per application should be used.

DISEASE CONTROL

DAMPING-OFF — Treat seed with a captan or thiram seed protectant. Sterilize soil for growing seedlings.

BACTERIAL WILT — The causal bacteria overwinter in and are spread by cucumber beetles which feed on cucumbers and other vine crops. Plants may become infected soon after they emerge when the crop is field seeded, or after transplants are set in the field and for the following three to five weeks. Beetles must be controlled (see Cucumber Beetles).

ANGULAR LEAF SPOT (cucumber) — See Seed Treatment. At first sign of disease, spray with a fixed-copper fungicide at 3.25 kg copper 50 WP per hectare, and repeat at weekly intervals in wet weather. Intervals may be lengthened if weather is dry. Do not work in crop when foliage is wet.

FUSARIUM WILT (muskmelon) — Sterilize soil for melon transplants. Grow Fusarium-resistant cultivars in infested soils (consult seed catalogue).

MOSAIC (VIRUS) — Grow cultivars reported to be highly resistant to mosaic (cucumber cultivars show a range of resistance). Consult seed catalogue. Since the virus is transmitted by aphids, spray or dust to control them (see Aphids). Because the virus overwinters in such perennial weeds as milkweed, ground cherry, pokeweed and motherwort, destroy nearby weeds in fencerows and waste areas.

SCAB (cucumber) — Where susceptible cultivars are grown, scab is often serious. Do not plant cucumbers following cucumbers. Beyond the seedling stage spray with one of:

1. chlorothalonil 500 4.8 L (1 day)
2. mancozeb 80 WP 3.25 kg (5 days)
3. benomyl 50 WP 550-850 g + mancozeb 80 WP 2.25-3.25 kg (5 days)

ANTHRACNOSE (muskmelon and watermelon) — Do not plant melons following melons. Spray seedlings as described above for control of scab on cucumbers. Beyond the seedling stage spray with one of:

1. captafol 480 F 2.75-5 L (1 day)
2. anilazine 50% WP 3.75 kg (1 day)
3. chlorothalonil 500 4.8 L (1 day)
4. mancozeb 80 WP 3.25 kg (5 days)

POWDERY MILDEW — Some cucumber and muskmelon cultivars are moderately resistant to mildew. As soon as mildew appears, spray with one of the following at 8- to 10- day intervals:

1. chlorothalonil 500 4.8 L (1 day)
2. benomyl 50 WP 550-850 g + mancozeb 80 WP 2.25-3.25 kg (5 days)

ALTERNARIA LEAF SPOT — This disease is often prevalent in muskmelons. The oldest leaves are infected first. Sprays applied to control scab and anthracnose are somewhat effective.

NEMATODES — See page 25.

INSECT CONTROL

Bee Warning

These insecticides, except rotenone, poison bees. Apply insecticides other than rotenone early in the day or in the evening when bees are not working in the field. If hives are in the crop, remove them when treating the field.

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. See Chemical Seed Treatment, page 26.

CUTWORMS — See page 24.

CUCUMBER BEETLES — Spray or dust when plants are breaking through and repeat, if beetles re-appear, with one of the following:

Spray:

1. methoxychlor 50% WP 3.25 kg (1 day)
2. endosulfan 50% WP 1.1 kg or 4 EC 1.5 L or 400 EC 1.5 L (2 days)
3. [2]azinphos-methyl 240 SC 2.25 L or 50 WP 1.1 kg (6 days)

Dust: rotenone 1% 40 kg (1 day)

Or use a commercial cucumber or melon dust containing an insecticide and fungicide.

APHIDS — Spray with one of the following which are listed in order of best control:

1. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L or 400 EC 1.5 L (2 days)
2. malathion 25% WP 3.25-4.5 kg (1 day, 3 days pumpkin)

SQUASH BUG (more common on squash and pumpkin) — Use one of the following:

Spray:

1. rotenone 5% WP 4.5 kg (1 day)
2. methoxychlor 50% WP 3.25 kg (1 day)

Dust: rotenone 1% 40 kg (1 day)

SQUASH VINE BORER (on squash) — Four insecticide applications one week apart starting in late June are required. Treat base of plants thoroughly with one of the following:

Spray:

1. rotenone 5% WP 4.5 kg (1 day)
2. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L or 400 EC 1.5 L (2 days)

Dust: rotenone 1% 40 kg (1 day)

Butternut squash is resistant to squash vine borer.

THRIPS AND LEAFHOPPERS — Spray or dust with methoxychlor, rotenone, or malathion at rates given for other insects.

TWO-SPOTTED SPIDER MITE — Spray with dicofol 35% AP 1.1 kg (2 days)

CUCUMBER (FRESH MARKET) MUSKMELON, WATERMELON, PUMPKIN AND SQUASH (Continued)

SAP BEETLES (melons) — Beetles infest and damage ripening fruit where the stem is attached to the vine and where the skin is diseased or injured. To reduce beetle injury, harvest the melons as often as possible at the half-slip stage. Remove all damaged fruit and culls from the field.

[2] *Minimum period before reentry is 48 hours.*

CURING AND STORING PUMPKIN AND SQUASH

Only the hard-shelled squashes are adapted for long storage, although pumpkins, properly handled, can be kept until after Christmas. After the fruits are harvested, they should be ripened or cured so they will keep longer and in better condition in storage. Curing hardens the shells, heals superficial wounds, reduces the high water-content of the fruit, and improves the eating quality. The fruits can be cured either by leaving them in small piles in the field for 10 days to 2 weeks when the weather is warm and dry, or by keeping them inside at room temperature for a month. The use of artificial heat to provide a temperature of 27 to 29°C combined with 80% relative humidity is a more reliable method which will reduce the curing period to about 2 weeks.

Unlike most other vegetables, squashes and pumpkins require warm, fairly dry storage conditions. After the curing period, carefully place the fruits in a single layer on shelves, leaving a small space between each fruit.

Maintain a temperature of 10 to 13°C and relative humidity of 70 to 75%. Too cold storage will cause a very rapid breakdown and rotting of fruit.

CUCUMBER (PROCESSING)

CULTIVARS

Hand-Pick

Earlipik 14
Bounty
Pioneer
Peto Triplemech
Score
Bonus
Pik-Rite (*trial*)

Once-Over

Earlipik 14
Peto Triplemech
Spear-It
Carolina
Score
Pik-Rite (*trial*)

All the cultivars listed are hybrids that have a predominately female flowering habit. A true gynoecious cucumber bears only female flowers. However, not all hybrids produce 100% female flowers. As many as 80% of the plants of many new hybrids may have some male flowers in Ontario fields. Our environment (e.g. daylength and temperatures) may be responsible for the presence of male flowers on these hybrids. From 10 to 15% of the seed sold as a gynoecious hybrid is a standard or monoecious cultivar, added as a pollinator. For satisfactory fruit set, 10 to 20% of the plants should contain a large number of male flowers.

The cultivars listed are recommended based on their suitability for either hand-pick or once-over mechanical harvesting. The hand-pick cultivars have performed well in trials and on growers' fields over the past several years. They include black and white-spined cultivars. Black-spined cultivars turn yellow as they reach maturity or if they are under stress. White-spined cultivars maintain their green color independent of stage of maturity and are preferred for once-over mechanical harvesting. The once-over cultivars listed are white-spined. All of these cultivars were bred especially for once-over harvesting of high plant populations.

SEED TREATMENT

See Cucumber (Fresh Market).

Seed provided by processors is usually treated with a seed protectant.

PLANTING

Pickling cucumbers are usually field-seeded from late May to early June for the handpick crop but for once-over mechanical harvesting, seeding can be done until mid-July. Quick uniform emergence is essential to avoid uneven stands and stands weakened by insects and disease. Because of a more-uniform depth of seeding and spacing of the seed, precision seeding tends to reduce plant stress and promote more-uniform crop emergence and development. Cucumber seeds will not germinate at a soil temperature below 10°C, germinate slowly at 20°C, with fastest germination at 25 to 30°C soil temperature. Delay seed sowing until the soil temperature is 15°C for higher. Seeding depth will vary depending on moisture. A soil cover of 20 to 25 mm is usually adequate. Cucumber seed should never be planted deeper than 25 mm.

SPACING

For the hand-harvested crop, rows are usually spaced 1.1 to 1.2 m apart with 6 to 10 plants per metre of row. This gives plant populations ranging from 50,000 to 90,000 plants per ha.

These spacings require from 1.7 to 3.0 kg of cucumber seed per ha. With average germination conditions, 1.0 kg of cucumber seed will give approximately 30,000 plants. Close spacing, rows 75 cm apart, have been successfully used by some growers. In general, the closer the spacing the higher the yield. However, very close spacing may present problems at harvest due to excessive vine, depending on cultivar, soil type and amount of rainfall.

For the once-over machine-harvested crop, the plant population for optimum yield will depend on soil type and availability of irrigation. Without irrigation, populations of 150,000 per ha are adequate. This population can be achieved by spacing rows 70 cm apart with 10 plants per metre of row and will require 5.0 kg of seed per ha. Higher populations, up to 200,000 plants per ha, can be achieved by spacing rows 50 cm apart with 10 plants per metre of row, requiring approximately 7.0 kg of seed per ha.

POLLINATION

With the use of hybrids and high plant populations, the provision of bees for pollination becomes extremely important. One honeybee colony per 50,000 plants during the blooming period is suggested. Insecticides will poison bees. See warning re bee poisoning on page 43.

CUCUMBER (PROCESSING) (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to 110 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — Broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. Alternatively, up to 100 kg of (N + K_2O)/ha can be applied in a band, 5 cm to the side and 5 cm below the seed at planting with the remainder of the fertilizer broadcast before planting.

The remainder of the N should be side-dressed before the vines begin to run, and on sandy soils a second application may be necessary after the vines begin to run if rainfall is excessive.

IRRIGATION — If the nitrogen is applied through the irrigation system, no more than 20 kg N/ha per application should be used.

DISEASE CONTROL

ANGULAR LEAF SPOT — Persistence of angular leaf spot in the field is a major problem. Infection of fruit is readily visible in the processed product (see Cucumber, Fresh Market).

SCAB — Grow scab-resistant cultivars. All pickling cultivars listed on page 44 are scab resistant. Also see Cucumber (Fresh Market).

OTHER DISEASES — See Cucumber (Fresh Market).

INSECT CONTROL

See Cucumber (Fresh Market).

EGGPLANT

CULTIVARS

(not revised for 1986)

Jersey King
Burpee
Black Magic

SEED TREATMENT

Sow hot-water-treated seed (see page 26). Before sowing, dust seed with thiram seed protectant.

SEED AND SPACING

Two hundred to three hundred grams of seed will produce enough plants for one hectare. Rows 90 to 120 cm apart, plants 45 to 60 cm apart.

GROWING THE PLANTS

Because eggplant requires a long growing season, it is started in a greenhouse or hotbed. The seed is sown in shallow flats of soil 9 to 10 weeks before field transplanting because the seed germinates slowly. Germinate seed at 27 to 29°C in flats of sterilized soil or whatever sterile medium is used for growing seedlings. It is important that the young plants are not checked in growth by cool temperatures, drought, cold drafts, or other causes. It is advisable to transplant the young plants to pots or bands before field setting to keep transplanting shock to a minimum.

Eggplants are hardened in the same way as peppers except that a higher temperature (18 to 21°C) is maintained.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to 70 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. (See tables on pages 14 and 16.)

APPLICATION — Broadcast 35 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed, 3 to 4 weeks after field setting.

STARTER SOLUTION — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high temperature conditions or in dry sandy soils reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment. Sow and transplant in steamed or fumigated soil. Drench flats at time of first watering with captan 50% WP (see label). When first true leaves develop, spray with captan or ziram and repeat every 7 to 10 days. Apply sufficient spray to wet the plants and run down the stems. (Also see Damping-off, page 27.)

VERTICILLIUM WILT — Sow and transplant in steamed or fumigated soil. Do not plant in fields where Verticillium wilt has been present unless the soil is treated with Vorlex 450L/ha, according to manufacturer's directions. Good weed control is an important part of wilt control. Wilt may be serious following peppers, tomatoes, eggplant and potatoes.

PHOMOPSIS BLIGHT — Avoid planting in infested fields for three years.

NEMATODES — See page 25.

EGGPLANT (Continued)

INSECT CONTROL

FLEA BEETLES — Spray plants just before field setting with one of the following insecticides. Repeat in the field if beetles appear.

1. endosulfan 50% WP 1.1 kg or 4 EC 1.5 L or 400 EC 1.5 L (2 days)
2. carbaryl 50% WP 2.25 kg or 85% WP 1.25 kg (1 day)

APHIDS — Spray with one of:

1. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L or 400 EC 1.5 L (2 days)
2. [2]demeton 240 SC 1.5-1.75 L (7 days)

The green peach aphid is becoming resistant to these insecticides in some areas.

TARNISHED PLANT BUGS — Endosulfan, as recommended for aphids, will give some control of tarnished plant bugs.

COLORADO POTATO BEETLE — Spray with carbaryl 50% WP 2.25 kg or 85% WP 1.75 kg (1 day). Repeat as necessary.

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[2] *Minimum period before reentry is 48 hours.*

LETTUCE

CULTIVARS

CRISPHEAD

TRANSPLANTS
Ithaca

SEEDED

Ithaca (early, mid, late)
Mesa 659 (late)
Montello (mid, late)
Green Lake (mid, late)

BOSTON AND BUTTERHEAD
- Buttercrunch
- Summer Bibb
- Dark Green Boston
- Citation

LEAF
- Black-Seeded Simpson
- Grand Rapids Forcing
- Deep Red

COS OR ROMAINE
- Paris Island Cos
- Valmaine Cos
- Signal

TEMPERATURE

Lettuce is a cool-weather crop and makes its best growth at temperatures between 16 and 18°C. Production is limited on mineral soils to the transplanted early crop and the seed-sown late crop. On muck soils, in cooler areas such as Bradford, lettuce may be produced throughout the growing season.

Properly hardened transplants, when set in the field in the early spring, can tolerate temperatures as low as -7°C. For the late crop on both muck and mineral soils seeding time is important. If plants are immature when the first frost occurs they will recover. Wrapper leaves on mature heads are very susceptible to frost and can only be marketed at a lower grade.

Germination occurs even at 4°C. At very high soil temperatures (27°C or above), germination is delayed.

SEED TREATMENT

See Chemical Seed Treatment page 26.

PLANTING

SEEDBEDS — About 275 grams of seed sown thinly in rows in flats should ensure sufficient plants to set one hectare. About two weeks later transplant about 5 cm apart in peat pots, plant bands, or flats.

Harden plants and thoroughly soak soil with starter solution (20-20-20) before transplanting in the field.

DIRECT-SEEDING — Sow seed in spring as soon as soil is ready. The rate is 1 to 2 kg per hectare.

The use of coated or pelleted seed with a precision seeder is worthy of trial. The stand and germination are more uniform, thinning costs are reduced, and higher percentages of cut are realized at harvest time.

SPACING — Leaf and butterhead cultivars 20 to 30 cm in rows about 30 cm apart. Crisphead lettuce 35 to 45 cm apart in rows about 40 cm apart.

THINNING — Thin when two or three leaves have formed.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22.)

NITROGEN — On MINERAL SOILS apply up to 110 kg/ha and on MUCK SOILS apply up to 120 kg/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — On MINERAL SOILS broadast half the nitrogen before planting and work in. Side-dress the balance 3 weeks after transplanting to the field or after thinning the seeded crop. On MUCK SOILS broadcast all the nitrogen before planting and work in.

MICRONUTRIENTS — COPPER deficiency may show up on acid, peat and muck soils. Copper may be mixed with the fertilizer and applied at 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

LETTUCE (Continued)

MANGANESE — Deficient lettuce shows marked yellowing between the veins; the veins themselves remain dark green. Manganese deficiency usually shows up on slightly acid or alkaline muck, peat and dark-colored sandy soils. Foliar applications, starting after thinning or transplanting, with manganese sulfate at rates supplying 0.5 to 1.0 kg manganese per 1000 L water are recommended where manganese deficiency has been a problem. Soil application is not recommended for manganese because of the large amounts required.

DISEASE CONTROL

DAMPING-OFF — Steam of fumigate soil for growing transplants (see Damping-off, page 27).

BOTRYTIS — Spray greenhouse-grown seedlings with 76% ferbam WP 2 kg/1000 L water, or dust with ferbam dust at 1-2 kg/100 m^2 of bed before first transplanting, and once or twice later at 10-day intervals.

DOWNY MILDEW in coldframes, greenhouses and on late lettuce — Spray every 7 to 10 days with one of:

1. zineb 80 WP 2. 25 kg (10 days)
2. maneb 80% WP 2.25 kg (7 days)

SCLEROTINIA MOLD (of lettuce, carrots, beans and celery) — Rotate with onions, beets or spinach for 2 to 3 years. Removal of crop refuse will help to control the disease. Use row and plant spacings to encourage good air movement.

ROOT ROT — Three- to four-year rotation. Do not plant lettuce following potatoes.

ASTER YELLOWS — See Leafhoppers (Insect Control section).

LETTUCE MOSAIC — Mosaic-indexed or mosaic-tested seed is available from most sources. This seed is produced in special areas where it is carefully checked to ensure that it is virtually free from seed-borne mosaic.

Control aphids as they spread the disease from infected lettuce plants and weeds such as groundsel, shepherd's purse, and lamb's-quarters.

NEMATODES — See page 25.

INSECT CONTROL

LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Spray lettuce 4 to 5 times at 5- to 7-day intervals, starting when leafhoppers first appear. Leafhoppers must be controlled in older patches by spraying as close to harvest as possible to protect nearby young plantings. Also spray weeds in headlands, ditchbanks, roadsides etc. and control leafhoppers on adjacent carrots and celery. After harvest, spray unmarketable heads and disk down 24 hours later.

Spray with one of:

1. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (3 days head lettuce, 14 days leaf lettuce)
2. [3]parathion 15% WP 2.25 kg (7 days head lettuce, 21 days leaf lettuce)
3. malathion 25% WP 4.5 kg (7 days head lettuce, 14 days leaf lettuce)
4. [1]mevinphos 450 mL (3 days)

OR apply phorate 15% G at 7.25 kg/ha in the fertilizer band on one or both sides of the row at seeding time, or when transplants are set in the field. See label for directions and cautions.

OR use disulfoton 15% G at 40-75 grams per 100 metres of row at seeding time, in a band on each side of the row. See cautions on the label. Do not use on transplanted lettuce. Use the higher rate on heavy and organic soils.

APHIDS — Spray with one of:

1. dimethoate 480 E 0.7 L or 40 EC 0.85 L (7 days)
2. pirimicarb 50 WP 300-500 g (7 days). Do not apply pirimicarb if lettuce is to be exported to the U.S.A.
3. disulfoton 15% G (see under Leafhoppers for rates etc.)
4. malathion 25% WP 4.5 kg (7 days head lettuce, 14 days leaf lettuce)
5. [3]*parathion 15% WP 2.25 kg or 960 E 350 mL (5 days head lettuce, 21 days leaf lettuce)
6. [1]mevinphos 450 mL (3 days)

*_The green peach aphid is becoming resistant to this insecticide._

CABBAGE LOOPER — Spray when loopers first appear with one of:

1. **_Bacillus thuringiensis_ 4.25 L or 1.1 kg (0 days)
2. [1]methomyl L 2.25-4.5 L (7 days) (Not on leaf lettuce)
3. [2]methamidophos 480 EC 1.25-2.25 L (14 days) (Not on leaf lettuce).

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[1] _Minimum period before reentry is 24 hours._

[2] _Minimum period before reentry is 48 hours._

[3] _Minimum period before reentry is 7 days._

**_See "Temporary Registration of Pesticides" inside front cover._

ONION

CULTIVARS

	Early	3 to 14 days later, in order of maturity
COOKING* (seeded)	Norstar	Fawn Preview
	Pronto S	Trapp's No. 6
	Rocket	Taurus
	Early Pak	Aries
		Nutmeg
		Trapp's No. 8
		Sweet Sandwich
		Buccaneer Improved
		Mucker
		Canada Maple
		Ontario M
		Autumn Keeper
		Exporter
		Russet
		Copra (*trial*)
		Sentinel (*trial*)
SETS		BUNCHING
Ebenezer (White and Yellow)		Japanese Bunching
White Portugal		Southport White Globe
Stuttgarter		White Knight
PICKLING		TRANSPLANTS
Pompei	pearl type	Sweet Spanish types (open pollinated)
Barletta		
Silver Queen		
White Portugal		*For muck soils*
		Brahma
		Cima
RED (in order of maturity)		Sierra
Ruby		Fiesta
Southport Red Globe (*trial*)		Matador
Red Wethersfield (*trial*)		
Benny's Red		
Carmen (*trial*)		

**See Cultivar Descriptions for suitability for storage.*

CULTIVAR DESCRIPTIONS

Aries — Good yield and quality, suitable for storage.

Autumn Keeper — Very firm, medium-sized, globe-shaped bulbs suitable for long-term storage.

Barletta — Used for pearl-onion processing.

Benny's Red — Red-skinned, attractive, matures about 2 weeks later than Autumn Spice, not for long storage.

Brahma — Large-bulbing, mid-season-maturing Spanish type, good resistance to bolting, high yield potential, good quality, light brown skin.

Buccaneer Improved — Very firm, globe shaped, excellent for long-term storage, high yielding.

Canada Maple — Bulbs firm, medium to large, round, high yield, suitable for long-term storage.

Carmen — Red-skinned, late maturing, globe shaped, firm, high-scoring hybrid, suitable for storage.

Cima — High yield potential, high quality, Spanish jumbo type, good resistance to premature bolting, globe shaped, light brown skin, mid-late-season maturing.

Copra — Very firm, very late maturity, high yielding, excellent scoring, excellent for long-term storage.

Early Pak — Very early, good yield, bulbs firm, medium size.

Ebenezer — (White or Yellow) — White Ebenezer is used for very early, mild, green bunching onions. Yellow Ebenezer is a set-onion type for the production of cooking onions.

Exporter — Deep-globe shape, very high yield, medium to large bulbs, well colored, less firm and shorter-term storage than Autumn Spice.

Fawn Preview — Medium-sized bulbs, high globe in shape, maturity similar to Autumn Spice, long-term storage.

Fiesta — Mid-season maturing, shallow globe, brownish yellow bulbs, resistant to bolting, good quality, Sweet Spanish hybrid.

Japanese Bunching — A non-bulb-forming, overwintering type, usually strong and pungent flavor.

Matador — Mid- to late-season-maturing Sweet Spanish of high quality, good resistance to bolting.

Mucker — High-globe shape, firm, good color, uniform, high yield.

Norstar — Very early maturing, large size, high yield potential, for short-term storage only.

Nutmeg — Early maturing, medium-sized bulbs, globe shaped, good color, medium to high yield, long-term storage.

Ontario M — Medium-sized bulbs, high globe in shape, good yield. Firmness and storage term are slightly less than Autumn Spice.

Pompei — White, earlier than Barletta, used for pearl-onion processing.

Pronto S — Soft, globe shaped, medium bronze, medium to high yield, not for storage.

Red Wethersfield — Red-skinned, firm, medium yielding, flat, good scoring, not suitable for long storage.

Rocket — High yield, somewhat lighter color and not quite so firm as Autumn Spice, suitable for long-term storage.

Ruby — Red-skinned, attractive, matures about 2 weeks later than Autumn Spice, short storage only.

Russet — Very high yield potential, very late maturing in Bradford area, fairly firm.

Sentinel — Very late maturing in Bradford area, very firm, excellent scoring marks, very good yield potential, excellent for long storage.

Sierra — Large deep-globe-shaped bulbs, maturing mid-season, brown skins, high quality, very good resistance to bolting. Sweet Spanish hybrid type.

Silver Queen — Used for pearl-onion processing.

Southport Red Globe — Red-skinned, relatively early maturing, fairly firm, medium yielding, good quality, suitable for short storage.

Southport White Globe — The main green bunching onion for early, mid, and late season.

ONION (Continued)

Stuttgarter — Set-onion type used for set production, prefers sandy loam.

Sweet Sandwich — Very high yielding, top shaped, very uniform size and shape, good color, relatively mild after some weeks in storage, suitable for medium long storage.

Taurus — Medium to early maturing, medium-large globe, good yielding, suitable for storage.

Trapp's No. 6 — High yield, globe shaped, good color, firm, suitable for long-term storage.

Trapp's No. 8 — Very firm, good yielding, globe shaped, high scoring, uniform, excellent color, long storage.

White Knight — A relatively new, long, white, green bunching type.

White Portugal — Used for green bunching, and for pickling.

SEEDING AND SPACING

Dry onions:	4 to 4.5 kg/ha
Bunching onions:	up to 7 kg/ha
Pickling onions:	35 to 45 kg/ha
Sets:	70 to 80 kg/ha

SPACING — Rows 35-42 cm apart or 15 and 60 cm apart alternately, with 20-40 plants per metre of row for dry onions and 10 cm apart in the row for Spanish transplants.

IRRIGATION

Onions have a shallow and limited root system, and should be irrigated frequently throughout the growing season. The soil moisture should not be permitted to fall below 50%. The plants should receive 25 mm of water a week, either as rainfall or irrigation.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — On MINERAL SOIL and on MUCK SOIL apply up to 110 kg/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — Apply 2/3 of the nitrogen before planting and the remainder sidedressed after the onions are about 15 cm tall.

MICRONUTRIENTS — COPPER deficiency occurs on acid, peat and muck soils. Onion bulbs show poor-colored skins. Copper may be mixed with the fertilizer and applied at rates supplying 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

MANGANESE deficiency shows up as a yellowing between the leaf veins. Foliar applications of manganese sulfate are recommended, starting when the plants are about 15 cm tall with 1.5-2.75 kg manganese per 1000 L water and repeated in 4 to 5 sprays 10 days apart. Use the low rate on small plants, increasing the rate as the season progresses. Soil application is not recommended for manganese because of the large amounts required.

MOLYBDENUM deficiency may occur when onions are grown on moderately acid to strongly acid muck soils. A seed treatment has proven beneficial. The treatment is accomplished by dissolving 15 grams of sodium molybdate in 45 mL of water. Spray this solution from an atomizer bottle on seed spread thinly on a plastic sheet. Do not use excessive water as this can cause the chemical to penetrate the seed embryo and cause injury. Mix the seed thoroughly and let dry.

Spraying plants with sodium molybdate at rates supplying 0.1-0.25 kg molybdenum per 1000 L also will help to avoid deficiency symptoms.

ZINC deficiency in onions shows up as a stunting and marked twisting and bending of yellow striped foliage. It occurs mainly with shallow muck soils or where the calcareous subsoils are mixed with the muck during a tile-drainage operation.

If zinc deficiency is a problem, spray the foliage with zinc sulfate at rates supplying 0.6 kg zinc per 1000 L water.

DISEASE CONTROL

DAMPING-OFF AND ROOT ROT — For Spanish onion transplants, treat seed with thiram seed protectant. Steam soil and flats.

For field-sown onions, treat seed with thiram.

DOWNY MILDEW, BORTYTIS LEAF SPOT AND PURPLE BLOTCH — Plant sets and mother bulbs as far as possible from onions being grown from seed. These diseases develop in humid weather or when rains and heavy dews occur frequently. Begin spraying when these conditions occur after early June in southwestern Ontario and after mid-June in the Bradford area. Then spray every 7 to 10 days with one of the following fungicides; a spreader-sticker may be required if recommended by the manufacturer.

1. zineb 80 WP 2.25 kg (7 days)
2. maneb 80% WP 2.25 kg (10 days)
3. mancozeb 80% WP 2.25-3.25 kg (10 days)
4. anilazine 50% WP 2.25 kg (7 days)
5. captafol 480F 5.5 L (1 day)
6. iprodione 1.5 kg (15 days) (not for downy mildew).

Note: Iprodione should be alternated with other fungicides listed above to avoid resistance. During cool wet weather favoring downy mildew, fungicides other than iprodione must be used.

SMUT — Use one of:

1. Thiram-insecticide combination (granules) — Apply at seeding time at a rate that supplies 2.25-3.25 kg (active ingredient) thiram per hectare; and add thiram 75% WP to the seed at 625 g for each kg of seed. See Onion Maggot.
2. Treat seed with carbathiin + thiram 50 grams to 2 kg of seed. Thorough mixing of carbathiin + thiram with seed is essential for good control. Mix until no uncoated seeds can be found. Read label directions. See Onion Maggot.
3. 37% formaldehyde — Add 1.25 L to 100 L of water and apply the diluted formaldehyde, while seeding, at 1000 L per hectare (rows 40 cm apart), or 4.5 L to 100 metres of row.
4. Steam soil for growing Spanish onion transplants.

ONION (Continued)

SOFT ROT, BOTRYTIS NECK ROT AND SMUDGE — Be certain onions are mature before harvesting. Cure and dry onions properly. Artificial heat may be beneficial. Store under cool, dry conditions. White and Spanish-type onions are more susceptible to these diseases.

WHITE ROT — This disease is present in Holland, Thedford, Grand Band and Point Pelee marshes. The fungus survives as sclerotia in the soil for long periods. The hosts are within the onion family: onion, shallot, leek, garlic. Long-term rotation with carrots, lettuce, potatoes or other crops not related to the onion family is recommended.

Sanitation is extremely important in preventing the spread of this disease. Wash down machinery after it has been used in an infested field. Avoid cultivation practices that can spread contaminated soil from one area to the rest of the field. Dispose of cull onions in a sanitary landfill or bury away from areas of onion production. Pallet boxes that have been used to hold contaminated soil or diseased onions may also be a source of disease. Dichloran may be helpful for control in the field. Follow manufacturer's directions.

NEMATODES — See page 25.

INSECT CONTROL

ONION MAGGOT

1. **Dry onions grown from seed** — Apply soil treatment as in (a) **and** spray for onion maggot flies as in (b).

a. **Furrow granular treatment:** Apply granular formulation in furrow with seed. See Smut. Amounts given are for one hectare. These dosages are based on single-row seeding spaced 40 cm apart. Growers should adjust the dosage if row spacing or planting methods differ.

Apply one of:

1. 5% fonofos-10% thiram combination, 22.5 kg (Do not use on mineral soils).
2. 5% chlorphenvinphos-10% thiram combination, 23 kg (for peat and muck soils only).
3. chlorpyrifos 15 G, 8-16 kg, **only with carbathiin + thiram-treated seed.** Use only on dry onions and pickling onions.

*4. 5% ethion-7.5% thiram combination, 35-45 kg.

*5. carbofuran 10G, 17 kg, **only with carbathiin + thiram-treated seed.** Do not use on pickling onions, green bunching onions, onions grown from sets, or Spanish onions from transplants.

**Resistance to these insecticides has been observed in Ontario muck soils.*

or

b. **Sprays for onion maggot flies: Proper placement of granular insecticides at the correct rate is the key to onion maggot control.** If difficulties are encountered with the granular application, sprays to kill the flies may reduce damage. Spray with one of the following materials in sufficient water to obtain good coverage as soon as flies appear. Repeat at 7- to 10-day intervals.

To limit the development of resistance, the insecticide from Group A must be used alternately with insecticides from Group B.

Group A:

1. cypermethrin 250 EC 280 mL (3 days)

Group B:

1. diazinon 50% WP 1 kg or 500 EC 1.5 L or 50 EC 1.1 L (10 days)
2. [3]parathion 15% WP 2.25 kg (15 days)
3. naled 8.64 EC 550 mL or 65.4 EC 500 mL (4 days)
4. malathion 500 EC 2.75 L (3 days)

In some areas monitoring programs are carried out for the onion maggot and treatments can be timed to coincide with peak activity of the adults. This may reduce the number of spray applications. Consult your Pest Management Specialist for timing.

Note: Permethrin 500 EC 280 mL (3 days) used for cutworm control on seedling onions will provide some control of onion flies (see page 24). This product also belongs in Group A, and the same considerations about alternating insecticides apply.

2. **Other Onions**

a. Dutch Sets — Make sure insecticide is distributed evenly over the width of the row. Special adaptations to equipment are necessary to meet this requirement. Apply soil insecticide treatment as in 1(a) and sprays as in 1(b).

b. Pickling Onions from Seed — Apply fonofos or ethion or chlorpyrifos as in 1(a) (for muck soils only) and sprays as in 1(b).

c. Green Bunching Onions from Seed — Apply ethion as in 1(a) and sprays as in 1(b).

d. Green Bunching Onions from Sets — Apply sprays as in 1(b).

e. Spanish Onions from Transplants — Special application equipment is required to distribute the insecticide in the furrow when the seedlings are transplanted. Use one of the granular materials listed in 1(a) and apply sprays as in 1(b).

f. Cooking Onions from Sets — Apply sprays as in 1(b).

Onions left in the field after harvest are a major source of overwintering onion maggot. This is especially true following early harvest of Dutch sets and pickling onions. Prevent all regrowth. Remove where possible, or plow under immediately after harvest.

THRIPS — [3]Parathion, as recommended as a spray for onion maggot flies, also controls thrips.

SPROUT INHIBITION

The use of maleic hydrazide sprays will improve the storage life and quality of onions by inhibiting sprouting in storage. Short-storage-life cultivars do not benefit from maleic hydrazide sprays. Apply according to manufacturer's recommendations, using the high rate for onions grown on muck soils. To obtain maximum benefit, spray when about 50% of the onion tops have fallen and most of them are still green, about two weeks to ten days before harvest. Earlier application may result in spongy, hollow-necked bulbs.

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[3] *Minimum period before reentry is 7 days.*

PARSNIP

CULTIVARS

Hollow Crown Model All-America

SEEDING AND SPACING

Parsnips are a long-season crop (100 to 130 days to maturity), so the seed must be sown as early as possible. Always use seed produced the preceding year. The seed is slow to germinate, especially in dry, cool soils. Poor stands occur if the soil surface becomes baked or crusted before the seedlings emerge.

RATE — 3 to 5.5 kg per hectare.

DEPTH — 6 to 20 mm.

ROW SPACING — 45 to 75 cm depending on machinery used in cultivation.

THINNING — Thin seedlings 3-6 cm in the row. On muck soils seeders should be adjusted to ensure a stand of 16 to 33 plants per metre of row.

SOIL

Parsnips require deep, loose, fertile soils, preferably a well-drained, warm sandy loam. Well-drained muck soils are also suitable. The desired pH is about 6.5.

FERTILIZER

Fertilizer requirements are the same as for carrots.

DISEASE CONTROL

ITERSONILIA CANKER AND LEAF SPOT — Starting August 1, or earlier if season has been wet, spray every 10 days, using tribasic fixed copper at 4 kg/ha. High ridging to cover the shoulder of the roots is helpful.

PHOMA CANKER AND LEAF SPOT — Hollow Crown and All-America are tolerant cultivars. Model is most susceptible. Rotate with other crops. Removal of crop refuse will help to control the disease.

ROOT-KNOT NEMATODES — See page 25.

INSECT CONTROL

LEAFHOPPERS — Spray with [3]parathion 15% WP 2.25 kg (15 days)

CARROT RUST FLY — This insect is mainly a problem in the Bradford & district Marshes. The carrot rust fly is monitored throughout the growing season in the Bradford area. The first generation of flies is normally present from late May until late June; the second generation from late July until September. Spray with [3]parathion 15% WP 2.25 kg (15 days) when recommended by your Pest Management Specialist.

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[3] *Minimum period before reentry is 7 days.*

PEA

For more detail, refer to OMAF Factsheet, *Peas for Processing*, Adgex 255/20.

CULTIVARS

(not revised for 1986)

MARKET	PROCESSING
Sugar Snap	As recommended by processors
Green Arrow	
Little Marvel	
Alderman (Tall Telephone)	
Progress Types	
Homesteader (Lincoln)	

SEEDING

DATE — As early as possible. Sowing of acreage for processing is now scheduled on the basis of accumulated heat units.

RATE — 250 to 400 kg/ha depending on seed size and percent germination.

DEPTH — During April and early May soil moisture is usually adequate and seed can be sown 2.5 to 4 cm deep. For later seedings a depth of 4 to 5 cm may be necessary.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — 15 kg N/ha is recommended at seeding where phosphate and potash are required. If no phosphate and potash are required the nitrogen may be omitted.

APPLICATION — Fertilizers should be broadcast and worked in before seeding. Do not drill fertilizer with the seed.

DISEASE CONTROL

ROOT ROT, WILT AND NEAR-WILT — Follow a 4-year rotation and other good management practices such as:

1. Select and plant only in well-drained fields.
2. Minimize soil compaction.
3. Work fields immediately after harvest.
4. Plant a green-manure crop such as sorghum, Sudan grass, or fall rye.

INSECT CONTROL

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. See Chemical Seed Treatment, page 26.

PEA APHID — This aphid is usually more abundant when peas are grown adjacent to clover of alfalfa. Various methods of sampling are carried out by fieldmen to tell whether sprays are

PEA (Continued)

required. Spray with one of:

1. dimethoate 480 E 425 mL (3 days). Do not feed or graze vines within 21 days of last application.
2. malathion 25% WP 4.5 kg or 500 EC 1.75 L (3 days)
3. [3]parathion 800 EC 275-525 mL (10 days). Do not feed or graze vines within 15 days of last application.
4. [2]demeton 240 SC 1.5 L (21 days)
5. pirimicarb 50 W 150-275 g (6 days). Use higher rate when aphid population is high and/or when very cool weather prevails. Use at least 17 litres of water by aircraft.

PEA WEEVIL — Infested seed should be fumigated. Use a commercial grain fumigant.

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[2] *Minimum period before reentry is 48 hours.*

[3] *Minimum period before reentry is 7 days.*

PEPPER

CULTIVARS

SWEET

EARLY

Vinedale
Sweet Hungarian (Yellow Banana)
Super Set 19 (hybrid)
Super Shepherd

MIDSEASON

Early Niagara
Golden Bell
Lady Bell (hybrid)
Hybelle (hybrid)
Pennbell
Staddon's Select

LATE

Bell Boy (hybrid)
California Wonder
Clovis (hybrid)
Emerald Giant
Greenboy (hybrid)
Gedeon (hybrid)
Keystone Resistant Giant
Midway
MA 79252 (hybrid) (*trial*)
Yolo Wonder 43

HOT

Long Thick Red
Hungarian Wax
Romanian Wax

CULTIVAR DESCRIPTIONS

Bell Boy — Thick-walled, medium-large, blocky fruit, good uniformity; high yields; plant large.

California Wonder — Standard cultivar, large vigorous plants, large blocky dark green fruits.

Clovis — Smooth, heavy, fairly early bell-type fruit on medium-sized, productive plants.

Early Niagara Giant — Large fruits with few locules, somewhat late, recommended especially for southern areas.

Emerald Giant — Very thick-walled, attractive, uniform, medium-large, bell-type fruit; productive; mid-late season; plants large.

Gedeon — Heavy, smooth, 4-lobed, very large bell-type fruit; plants large with good fruit cover.

Greenboy — Thick-walled, attractive, fairly heavy bell type; excellent yields on medium-large plants, particularly late in season.

Golden Bell — Bright orange, attractive, heavy sweet bell type; reliable producer.

Hungarian Wax — Hot pickling type, prolific, 12 to 15 cm long, yellow fruits turn to crimson when mature.

Hybelle — Thick-walled, 3-4-lobed, blocky fruit on fairly large, vigorous plants; early-mid season; dependable setting.

Keystone Resistant Giant — Heavy-walled, medium-sized, blocky, bell-type fruit; plants medium size; most productive in southwestern Ontario.

Lady Bell — Fairly thick-walled, 3- to 4-lobed bell type; flat plant; dependable producer.

Long Thick Red — Hot, approximately 15 cm long, dark green shiny fruits, turning early to brilliant red when mature.

Midway — Large, smooth, attractive, uniform, blocky fruits, relatively small plants.

MA 79252 — Large upright plant with good foliage cover; 3- to 4-lobed, blocky, thick-walled, large fruit; mid-late season.

Romanian Wax — Hot pickling type with upright semi-long pointed fruits.

Staddon's Select — Good producer especially in the southern areas; fruits are smooth, large, dark green.

Super Set 19 — Heavy set of medium-size, bell-shaped, thick-walled fruit on medium sized plants, early in southwestern Ontario.

Super Shepherd — Early, productive, with 15- to 18-cm pointed pendant fruit with thick walls.

Sweet Hungarian (Yellow Banana) — Long, slender fruits with a diameter of 4 to 5 cm at the shoulder gradually tapering to a point, light cream in color.

Vinedale — Fruits dark green with thick walls, medium size, smooth pointed pimento shape, especially suggested for Niagara Peninsula.

Yolo Wonder 43 — Long bell-type, slightly tapering, dark green fruits often with only two locules.

SEED TREATMENT

Sow hot-water-treated seed (see page 26). Before sowing, dust seed with thiram seed protectant.

SEEDING AND SPACING

Two hundred grams of seed should produce enough plants for a hectare.

Rows 90 to 120 cm apart. Plants 35 to 45 cm apart.

PEPPER (Continued)

GROWING THE PLANTS

Because peppers require a long growing season, they are started in a greenhouse or hotbed. The seed is sown in shallow flats of soil 9 to 10 weeks before field transplanting because the seed germinates slowly. A temperature of 27 to 29°C is required for good seed germination and steady plant growth.

When the first true leaves are about 1.5 cm long, transplant the seedlings to other flats containing a fertile compost soil. Space the plants 5 to 7 cm apart. Where space is available, transplanting to 8- to 10-cm plant containers will produce larger plants with compact, well-developed root systems. These plants suffer less from transplanting shock.

Alternatively, plants can be raised by seeding raw or pregerminated seed directly into peat pots, multi-pot trays, wedge-shaped plant modules such as speedling flats, or directly into beds filled with special growing media. Such a system is less labor intensive, results in superior plant material raised in a shorter time and reduces transplanting shock.

Pepper plants are hardened for about one week before transplanting to the field by reducing the soil moisture supply and maintaining a temperature of 13 to 16°C. Hardening of pepper plants gives resistance to wilting, but not to frost.

COLD TREATMENT

The number of flowers and fruits on the plants can be increased by exposing the seedlings to a controlled cold treatment, as follows:

1. Germinate seed at 27 to 29°C in flats of sterilized soil or whatever sterile medium is used for growing young seedlings.
2. When the third true leaf of the seedlings appears, grow the plants at a minimum night temperature range of 12 to 13°C for 4 weeks. The plants can receive the cold treatment either before of after the first transplanting. The plants should receive as much sunlight as possible.
3. After 4 weeks of cold treatment, grow the plants at the recommended temperature of 21°C.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to 70 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — Broadcast 35 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed, 3 to 4 weeks after field setting.

STARTER SOLUTION — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high temperature conditions or in dry sandy soils reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment and sections on Hot-Water Seed Treatment and Damping-off of Seedling (pages 26 and 27). Because unsterilized soil and mixes containing peat moss, pit sand and soil often give rise to damping-off, sow and transplant only in a sterilized medium. Drench flats at time of first watering with captan 50% WP or 80% WP (see label). Spray when first true leaves develop, with captan 50% WP 2.25 kg and repeat every 7 to 10 days. Apply sufficient spray to wet plants and run down stems.

BACTERIAL LEAF SPOT — See IN THE SEEDBED in the disease-control section of Tomato, page 00. If this disease shows up on plants in the field, apply one of the copper bactericides tank-mixed with mancozeb 80 WP at 2.25 kg product per hectare. Do not delay spraying these compounds once mixed in the tank. In periods of extended wet weather, a control using copper materials may not be satisfactory. Shortened spray intervals to 3 to 5 days may be necessary to provide adequate protection.

VIRUS — Control aphids (see Insect Control). Some cultivars have considerable resistance to some viruses. (Consult seed catalogue.)

VERTICILLIUM WILT — Grow seedlings in sterilized soil. Wilt may be serious following peppers, tomatoes, eggplant and potatoes.

NEMATODES — See page 25.

INSECT CONTROL

APHIDS — Spray with one of the following which are listed in order of best control:

1. pirimicarb 50 W 275-550 g (3 days)
2. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L or 400 EC 1.5 L (2 days)
3. diazinon 50% WP 1 kg (5 days)
4. [2]demeton 240 SC 1.75 L (3 days)
5. dimethoate 480 E 0.7-1 L (3 days)

TARNISHED PLANT BUGS — Dimethoate, as recommended for aphids, will give some control of tarnished plant bugs.

CORN BORER — Weekly treatments throughout August and September are recommended. Earlier applications may be required for the fresh-market crop or when fruit is present. A European corn borer monitoring service now provides information on adult flight patterns. Consult Agriphone for details. For chemical control, thorough distribution of spray material is required. If a hydraulic boom sprayer is used, solid- or hollow-cone nozzles on drop pipes have improved coverage. Add an insecticide for aphids when needed. Carbofuran also suppresses aphids.

Use one of:

1. **deltamethrin 2.5 EC 600-700 mL (3 days)
2. permethrin 500 EC 140 mL (1 day)
3. [2]carbofuran 480 F 1.1 L (3 days). Do not use more than 6 applications per season.
4. carbaryl XLR 2.5-5.25 L or 50% WP 3.25 kg or 85% WP 2 kg (1 day). In areas where corn borer has been a severe problem, spray every 4 days.

PEPPER MAGGOT — In areas where required apply 4 sprays at 7-day intervals starting the last week of June or first week of July using one of:

1. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L or 400 EC 1.5 L (2 days)
2. malathion 25% WP 5.5 kg (3 days)
3. dimethoate 480 E 0.7-1 L (3 days)

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[2] *Minimum period before reentry is 48 hours.*

***See "Temporary Registration of Pesticides" inside front cover.*

POTATO

For more detailed information see OMAF Publication 534, *Potato Production in Ontario.*

CULTIVARS FOR CLIMATIC ZONES IN ONTARIO

(not revised for 1986)

Zone[1]	Early	Midseason	Late
A & B	Jemseg Superior Conestoga Simcoe	Chieftain Kennebec Trent	Kennebec[2]
C & D	Jemseg Superior Yukon Gold Conestoga Simcoe	Norchip Kennebec Chieftain Trent	Chieftain Kennebec Rideau Shepody Nipigon
Thedford Marsh	Superior Yukon Gold	Chieftain Kennebec Trent	Kennebec Rideau Shepody Sebago
E	Superior Yukon Gold Conestoga Simcoe	Keswick[3] Norchip Chieftain Trent	Kennebec Rideau Shepody Nipigon Russet Burbank
Bradford Marsh	Superior Yukon Gold Simcoe	Norchip Chieftain	Chieftain Rideau Nipigon
F	Yukon Gold	Keswick Trent Nipigon	Chieftain Kennebec Rideau Russet Burbank
G	Yukon Gold	Keswick Trent Rideau Nipigon	Chieftain Russet Burbank

[1] *See Figure 1 on page 9.*

[2] *For local processing trade only.*

[3] *Not satisfactory in southern part of Zone E.*

CULTIVAR DESCRIPTIONS

Listed in order of maturity

Jemseg — Very early; smooth, blocky tubers; high yield; good for boiling; chips when harvested; not a storage potato; immune to virus X; resistant to common scab and to viruses Y and S; susceptible to virus leafroll, Verticillium wilt and Fusarium storage rot; may have a poor stand if cut seed is used.

Superior — Early; fairly smooth; high-yielding; good for table-stock and as a mid-summer chipper; scab resistant but very susceptible to Verticillium wilt at maturity; may be subject to seed-piece decay in a wet spring.

Yukon Gold — Medium-early, round; smooth; yellowish, finely flaked skin with pink eyes; yields with Russet Burbank but is much earlier; both raw and cooked flesh yellow; good boiling, baking and French-fry quality; chips dark; upright vines; moderately susceptible to common scab and virus Y; resistant to mild mosaic and moderately resistant to virus leafroll.

Conestoga — Medium-early, blocky, fairly smooth; very vigorous early growth; yield comparable to Superior; very good boiler, baker and chipper; better chip color and specific gravity than Norchip; moderately resistant to virus leafroll, net necrosis, early blight and common scab; moderately susceptible to mild and rugose mosaic.

Simcoe — Medium-early, round, slightly flattened, smooth; yield comparable to Norchip but tuber size larger; excellent boiling, baking and chipping quality; specific gravity and chip color rating higher than Norchip; resistant to mild mosaic, late blight and the golden nematode; moderately resistant to common scab; moderately susceptible to Rhizoctonia; susceptible to virus leafroll; must be planted early for maximum yield.

Keswick — Midseason; light green foliage; fairly smooth under close spacing; good cooking quality; makes good midseason French fries; scab- and late blight-resistant.

Norchip — Midseason or early maincrop; slightly rough, roundish tubers which are small at close spacing; need 40- to 45-cm spacing for better size; medium yield, but high quality for processing, especially from storage; susceptible to early and late blights, Verticillium wilt, silver scurf, and spindle-tuber.

Chieftain — Midseason or early maincrop; fairly smooth, bright red skin; high yield; good cooking quality, but does not process; susceptible to Verticillium wilt and spindle-tuber, also to silver scurf in zones A-D; resistant to scab, mild mosaic, net necrosis and the late blight.

Trent — Medium-late; smooth; yields 80% of Kennebec but much less oversizing; good boiling, baking, chip and French-fry quality; high specific gravity; moderately susceptible to scab and late blight; susceptible to mosaic-type viruses.

Kennebec — Normally maincrop but sizes early in Zones A and B with early planting; high yield; smooth under close spacing; good chip and French-fry quality; tubers green rapidly under light and may become bitter; late blight-resistant; scab-tolerant; very susceptible to Verticillium wilt.

Rideau — Maincrop; round; smooth; bright red skin which keeps color well in storage; high yield of No. 1; excellent boiler and good baker; does not chip or French-fry; very resistant to Verticillium wilt; moderately resistant to common scab, mild mosaic, rugose mosaic and virus leafroll; moderately susceptible to Rhizoctonia.

Shepody — Maincrop; long oblong; fairly smooth; light tan skin with a medium net; good yield and size; excellent boiler, baker and French-frier; poor chipper; resistant to early blight; moderately resistant to Rhizoctonia, Phoma and Fusarium storage rots; susceptible to common scab, Verticillium wilt, late blight and virus Y.

Nipigon — Maincrop in southern districts but midseason in the north; tubers slightly irregular but very clean and white; often outyields Kennebec; good boiler and baker; moderately resistant to scab and the mosaic viruses; resistant to blackleg; very resistant to drought and the common races of late blight; susceptible to heat necrosis in hot soils.

Russet Burbank (Netted Gem) — Long, heavily-netted russet; late; very high baking and French-frying quality; often sloughs when boiled; needs 30- to 36-cm spacing in 90-cm rows; wider spacing may be desirable in coarse, unirrigated soils; must have regular, adequate moisture (25 mm per week) throughout growing season to avoid misshapen tubers; scab-resistant; susceptible to most viruses, late blight and Verticillium wilt.

POTATO (Continued)

Sebago — Very late; good cooking quality; does not chip as well as Kennebec; sprouts early if stored above 4°C; scab- and late blight-resistant; very susceptible to blackleg.

SANITATION

The storage and all potato equipment including cutting knives and containers should be completely cleaned before using. Clean out and thoroughly scrub with detergent all machinery, equipment, walls, floors etc. and then use a quaternary ammonium compound such as King Anti-Ring Rot disinfectant or Niagara HY-X disinfectant. All cull potatoes should be spread out on the field to freeze, or destroy all potato foliage on cull piles early in the season with a suitable vine killer.

SEED HANDLING AND TREATMENT

Plant Foundation or Certified seed to reduce loss from leaf roll and other viruses, bacterial ring rot, Verticillium wilt, Rhizoctonia, and common scab.

Inspect seed on arrival and during cutting. Discard tubers and seed pieces showing rot.

Before seed is cut, warm it at 18 to 21°C for about 2 weeks in good light. Cut seed should be planted immediately. If this cannot be done, store in containers such as crates or burlap bags stacked to allow air movement around each container. Hold at 10 to 15°C and high relative humidity for 3 to 4 days to allow wound cork to form over cut surfaces. Never allow cut seed to stand in the hot sun or in drying wind. Do not plant in hot, dry soil or in cold, wet soil.

Do not plant potatoes within 3 weeks of plowing down a heavy stand of mature rye.

Chemical Treatment — Seed-piece treatments with a commercial dust may be beneficial, particularly in areas where maggots are a serious pest. The following commercial dusts may be used (rates are for 50 kg of cut seed):

1. metiram-diazinon dust at 450-700 g
2. captan 7%-diazinon 0.1% dust at 450 g
3. thiophanate-methyl (Easout) Potato Seed Piece Treatment at 250 g.

SOIL

A soil pH of 6 to 7 is desirable for optimum growth of potatoes. However, lower pH values down to 5.0 may provide better control of scab. Apply limestone to rotation crops where possible, and in the fall if potatoes follow potatoes.

Soil organic matter can be maintained by use of well-decomposed barnyard manure, grass or legume sod crops, or cover crops. A thick cover crop seeded after early potatoes will reduce soil blowing and fertilizer leaching. Manure should fall applied and incorporated.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply 130 kg N/ha on MINERAL SOILS and up to 100 kg N/ha on MUCK SOILS. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — On MINERAL SOILS testing medium or low for phosphate, some or all of the phosphate fertilizer should be placed in bands 2.5 cm below and 6 cm to each side of the seed piece at planting time. On MUCK SOILS or on MINERAL SOILS testing high for phosphate, placement is less critical and fertilizer may be broadcast.

If the total N plus K_2O applied is over 360 kg/ha at least a portion should be broadcast before planting to avoid too concentrated a band near the seed piece and potato roots. Broadcasting or side-dressing N after potatoes are 20 cm high is not generally recommended because it may delay maturity.

PLANT ANALYSIS — Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately. For potatoes the fourth leaf, including stem, from the growing tip at early bloom is recommended. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant-analysis results when the samples are not taken at early bloom. A soil sample should be taken from the same area and at the same time as a plant sample. For more information on plant analysis see page 16.

INTERPRETATION OF PLANT ANALYSIS FOR POTATOES

Nutrient	Units	Critical Concentration*	Maximum Normal Concentration**
Nitrogen	%	2.50	3.50
Phosphorus	%	0.15	0.50
Potassium	%	1.20	2.50
Calcium	%		1.50
Magnesium	%	0.10	0.60
Sulfur	%	0.14	
Boron	ppm (ug/g)	2	25
Copper	ppm	2	20
Manganese	ppm	15	150
Zinc	ppm	14	70

Values apply to the fourth leaf, including stem, from the growing tip at early bloom.

**Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

***Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

DISEASE CONTROL

Practise a suitable crop rotation to prevent build-up in the soil of organisms causing blackleg, wilt, Rhizoctonia, common scab, early blight and silver scurf.

SEED-PIECE DECAY — See Seed Handling and Treatment.

COMMON SCAB — Choose a resistant cultivar suitable for the area and the market. See Soil Reaction, and Seed Handling and Treatment. Where irrigation is available, it is important to maintain high soil moisture for about 4 weeks after tuber setting begins where scab has been a problem.

POWDERY SCAB — Only a problem in Northern Ontario. Plant Foundation or Certified seed. Plant in warm, well-drained soil. Dop not plant in fields in which powdery scab has occurred.

POTATO (Continued)

RHIZOCTONIA — Avoid land known to be heavily infested. Rotate the crop, e.g. spring barley on mineral soil, or onions on muck soils. To reduce attacks on eyes and sprouts, plant to a depth of 8 to 10 cm without hilling. See Seed Handling and Treatment.

VERTICILLIUM WILT — On land where this disease was severe allow at least a two-year rotation with a cereal, corn or other suitable non-Verticillium-susceptible crop. To be effective, a high degree of weed control is absolutely essential.

BACTERIAL RING ROT — See section on Sanitation. Do not save any of your own potatoes for seed.

BLACKLEG — (a bacterial disease) — See Seed Handling and Treatment and section on Sanitation. Planting whole seed may help reduce loss.

SPINDLE TUBER — Use Foundation or Certified seed. Inspect your seed carefully for signs of spindle-tuber infection (see OMAF Publications 534, *Potato Production in Ontario*). If present in any significant amount, do not use as seed.

LEAF-ROLL VIRUS AND NET NECROSIS — Use Foundation or Certified seed. Because leaf roll is spread by aphids, the control of this insect is important, especially with the cultivar Russet Burbank, to avoid net necrosis caused by current-season infection.

EARLY BLIGHT — Early blight is particularly damaging to the cultivars Norchip and Superior. Begin your fungicide spray program early so lower plant foliage is well covered. This is where blight infections first begin. Conditions favorable for disease development are combinations of temperatures between 17-24°C and 12 hours of leaf wetness throughout the plant canopy. In addition, stress conditions such as drought, insect damage, air pollution, rapid growth at tuber sizing, increase the foliage susceptibility to early blight. Under these conditions spray intervals should be shortened to 7 days.

LATE BLIGHT — **Destroy all culls.** Use a suitable vine killer early in the season on any foliage that may develop on over-wintered cull piles. Using a cultivar with tolerance or resistance to late blight makes the spray program more effective by reducing the chances of infection. Plant Certified seed. If requested, seed will be inspected by federal inspectors.

Fungicides for late-blight control should be applied starting as soon as moist cool conditions are forecast in July, particularly if the foliage is about 20 cm high. **Cool, moist** conditions (temperature 10 to 15°C with dew, rain, or relative humidity above 90%) are favorable for late blight. Ten hours or more of moist, muggy weather favors late-blight development. During continuously moist weather, intervals between spray applications should not exceed 7 days. During warm dry periods, spray intervals may be extended to 14 days.

Note: If tubers are of marketable size and late blight is present in the field, apply a top killer to prevent tuber infection. After applying the top killer, wait at least 10 days before harvesting. Discard tubers affected by rot at harvest-time. Do not pile culls; spread them out so they will freeze, since the late-blight fungus will survive in culls that survive the winter.

EARLY AND LATE BLIGHT CONTROL

Use one of the following:

1. chlorothalonil 500 1.75-2.25 L (1 day)
2. captafol 480 F 1.75-3.25 L (1 day)
3. mancozeb 80 WP 2.25 kg (1 day)
4. maneb 80% WP 2.25 kg (1 day)
5. metiram 80 W 2.25 kg (1 day)
6. **metalaxyl/MZ 72 W 2.5 kg (1 day). Use at 10- to 14-day intervals. For late blight only.

NEMATODES — See page 25.

***See "Temporary Registration of Pesticides" inside front cover.*

INSECT CONTROL

CUTWORMS, WIREWORMS AND WHITE GRUBS — See pages 24 and 25.

FOLIAGE INSECTS

a. *Soil Treatment.* **For main crop and seed potatoes only. Do not dig potatoes within 90 days of application.**

It is possible to control Colorado potato beetles, leafhoppers, flea beetles and aphids early in the season with one of the following granular materials applied in the furrow at planting time.

These chemicals are extremely toxic. Carefully follow all precautions given by the manufacturer.

1. aldicarb 10% G, 22.4 kg (90 days).
2. phorate 5% G, 14.5-22.4 kg (90 days). Use the higher rate on heavy silt or clay loam soils. Do not use on muck soils.
3. carbofuran 10% G, 32.5 kg (90 days). Does not control aphids.
4. disulfoton 15% G, 15-22.5 kg or 720 LC 2.75-4.75 L (90 days). Do not allow the 720 LC formulation to come in contact with the seed piece. For both formulations use the higher rate on clay and muck soils.

Note: To reduce the possibility of ground water contamination and slow the development of potato beetle resistance, alternate insecticides each year.

For **late-season** control, apply an appropriate foliage insecticide from section *b.* or *c.* If soil was treated at planting time with disulfoton or phorate, choose an insecticide from Group B or C; if it was treated with carbofuran or aldicarb, choose from Group A or B.

b. ***Spray Program.*** To control Colorado potato beetles, potato flea beetles, tarnished plant bugs or potato leafhoppers, use one of the following insecticides.

NOTE: To slow the development of resistance it is important to alternate insecticides, choosing one from a different group each time you spray.

GROUP A

1. [1]methidathion 250 EC 1.1 L (14 days)
2. [2]methamidophos 480 EC 1.75-2.25 L (14 days)
3. chlorpyrifos 4E 1 L (7 days)
4. [2]azinphos-methyl 240 SC 2.25 L (1.5 L for Colorado potato beetle) (7 days)
5. phosmet 50% WP 2.25 kg (7 days)

POTATO (Continued)

GROUP B

1. **deltamethrin 2.5 EC 200-300 mL (23 days) (Do not use on high organic (muck) soils).
2. **fenvalerate 300 EC 100-150 mL (7 days)
3. permethrin 500 EC 150-200 mL or 384 EC 185-275 mL (1 day)

GROUP C

1. [2]carbofuran 480 F 1.1 L (550 mL for Colorado potato beetle only)(7 days)
2. [1]oxamyl L 2.3-3 L (7 days)

c. ***Aphids.*** For green peach, potato or Buckthorn aphids, apply one of the following:

1. [2]methamidophos 480 EC 1.75-2.25 L (14 days)
2. pirimicarb 50 W 450-550 g (3 days)
3. [2]oxydematon-methyl 240 SC 1.75-2.25 L (7 days)
4. [1]oxamyl L 3 L (7 days)
5. dimethoate 480E 550 mL-1. 1 L (7 days)
6. **fenvalerate 300 EC 225-325 mL (7 days)

d. ***Late-Season Cutworms*** - have caused both tuber and foliage damage. For control of cutworms which are active above the soil surface, prior to tuber feeding, apply permethrin 500 EC at 140 mL/ha (1 day) or chlorpyrifos 4E 1 L/ha (7 days). Ensure thorough penetration of dense foliage. Re-treat if necessary. Check with your local OMAF Pest Management Specialist or Crop Advisor regarding insect adult flights to aid spray-timing decisions.

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[1] *Minimum period before reentry is 24 hours.*

[2] *Minimum period before reentry is 48 hours.*

***See "Temporary Registration of Pesticides" inside front cover.*

SPROUT INHIBITION

After completion of a rest period, potatoes sprout readily. Potatoes treated with chemical sprout inhibitors can be stored at 10°C or higher without sprouting.

FIELD-APPLIED. Maleic hydrazide is a plant growth regulator, applied as a single application in the field to control sprouting of potatoes in storage.

It should be applied in a manner that insures complete and uniform coverage. Timing is important. Recent research has shown that too early an application, on some cultivars, such as Norchip, may result in reduced potato size and phytoxicity.

Consult manufacturer's recommendations and your local OMAF Crop Advisor for more detailed information on both rates and timing. Time of application may occur as early as 2-3 weeks past full bloom. Only apply to plants that are still green and free from insects, disease and other damage.

Once in storage, tubers treated with maleic hydrazide will *not* affect seed potatoes stored in the same storage, or those stored in crates formerly used for the storage of maleic hydrazide-treated tubers.

STORAGE-APPLIED. CIPC is another chemical which is widely used for sprout inhibition.

Apply it in storage as a dip, spray or aerosol just before sprouting starts. Potato tubers may be treated with this chemical before packaging for market. Do not apply CIPC at harvest time.

Do not use either of these treatments on potatoes grown for seed. Do not store seed potatoes in the same storage with CIPC-treated tubers, or in crates which were in the storage when CIPC was applied.

VINE KILLING

Vine killing is especially important to growers of Certified seed as an early kill controls tuber size and reduces the spread of virus diseases by aphids.

Chemical vine killers are not recommended for early potatoes because they limit the yield, size and dry-matter content without reducing skinning.

Use diquat or dinoseb according to manufacturer's directions, which will vary according to plant vigor and the type of growing season. **Ensure that no drift occurs from any of these materials to adjacent crops** because the residue of these compounds on other crops may result in their seizure.

Allow at least 14 to 21 days between vine-killing and harvesting so that skins of the tubers may set. For proper rate and time between application and harvest, consult labels for individual chemicals. If late blight is present a quick kill is desirable; this may cause a slight darkening at the stem end of the tubers but will not change the specific gravity.

The use of roto-beaters is not recommended except where dead vines or weeds are a hindrance to the digger.

STORAGE

Store seed tubers separately from table-stock potatoes, in a clean storage. Do not store seed potatoes in the same storage with CIPC-treated tubers.

Healing of cuts and bruises is most rapid at a tuber temperature of 15 to 21°C. It is desirable to provide this temperature for two to three weeks at the beginning of the storage period. After this the temperature should be lowered to 5°C if potatoes are intended for table stock or seed. Potatoes intended for processing should be maintained preferably at 10°C and never should be subjected to temperatures below 5°C. It will be necessary to use a sprout inhibitor if potatoes are to be stored at 10°C for an extended period.

The relative humidity in the storage should be as high as possible without causing condensation of moisture on tubers and the storage structure. However, if soft rot is prevalent or if the tubers are wet when first put into storage, the humidity should be kept down until the tubers are dry.

RADISH

Radish, a cool-season crop, is adversely affected by hot, dry weather, and remains in prime condition only a few days. To be mild, tender and attractive, it must be grown rapidly with plenty of moisture. If growth is checked the roots become hot, tough and pithy. Under medium- to short-day length, roots are normally well-shaped and tops relatively small. Under long days (15 hours) roots are misshapen, tops are long and usually produce seed stalks.

CULTIVARS

(not revised for 1986)

Mineral soil	**Muck soil**
Cherry Belle	Champion
Red Prince Improved	Scarlet Globe Special
Scarlet Globe Special	Cavalier
Scarlet Knight	Comet
Stoplite	Cherry Belle
Robijn (*trial*)	Red Prince Improved
Rondeel (*trial*)	Scarlet Knight
	Stoplite

Cultivars or strains with globe-shaped roots entirely red in skin color, and with leaves that are short to medium in length, are the most popular. Medium-top strains are preferable for early spring crops and short-top strains preferable during the longer day period.

SEED TREATMENT

See chemical Seed Treatment page 26.

SEEDING AND SPACING

SEED — 11 to 17 kg per hectare. Use 22 to 34 kg/ha for machine harvesting.

SPACING — Rows 20 to 30 cm apart. Plants 40 to 50 per metre of row. For machine harvesting, space rows 10 to 15 cm apart.

SPRING CROP — The seed may be sown in the spring as soon as the soil is workable. Spring frosts, or even heavy snowfalls, after the plants have emerged, usually do not injure the crop seriously. Under favorable weather conditions radish seedlings appear above ground two or three days after sowing. Sowing at intervals in the spring will provide a continuous harvest.

SUMMER AND FALL CROP — Radishes are grown successfully on muck soils throughout the growing season because such soils are usually well supplied with moisture, and provide a cool growing medium. Only large-sized seed of the short- to medium-foliage cultivars or strains of radishes should be used.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements (See tables on pages 21 and 22).

NITROGEN — On MINERAL SOILS apply up to 60 kg N/ha. On MUCK SOILS apply 55 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

INSECT CONTROL

FLEA BEETLES — To limit the development of resistance the two insecticides below should be used **alternately.**

1. permethrin 500 EC 140 mL (2 days)
2. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (7 days)

APHIDS — Spray with [3]parathion 15% WP 2.25 kg (15 days).

CABBAGE MAGGOT — Spray plants at or just after emergence with [3]parathion 15% WP 2.25 kg (15 days).

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[3] *Minimum period before reentry is 7 days.*

RHUBARB

CULTIVARS

Outdoor	**Forcing**
Timperley Early	Timperley Early
Valentine	Victoria
Macdonald	Sutton
German Wine	

SPACING

Rows 90 cm apart, plants 90 cm apart in the row (11,950 plants per hectare). To produce roots for forcing, spacing in the field may be adjusted to 75 cm between rows and plants (17,220 plants per hectare) without any loss of yield or quality.

PLANT SELECTION

A number of virus and other diseases reduce the vigor of the plant and the yield, both in the field and in the forcing shed. Plants with vigorous growth should be marked during June and left in the field until the following spring, then dug up and used as planting stock. The remainder should be discarded.

FLOWER-STALK REMOVAL

Flower stalks should be cut out while they are still small, and in any case before the flowers open. This can conveniently be done at the same time as harvesting a crop for processing, but in crops grown for early fresh marker, or for forcing, a separate operation will be necessary.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to 280 kg N/ha.

APPLICATION — PREPLANTING — Plow under 45 to 90 tonnes/ha of manure in the fall. Broadcast and cultivate in 100 kg N/ha, with all of the phosphate and potash required, before planting.

RHUBARB (Continued)

ANNUALLY — Just before the buds break each spring apply 180 kg N/ha, with the phosphate and potash required (based on a soil test) as a broadcast dressing, or preferably as a side-dressing at a 10-cm depth. Immediately after pulling the crop for processing, apply broadcast 100 kg N/ha. The same amount may be applied in July to plants to be used for forcing.

IRRIGATION — As much as 100 kg N/ha may be applied through the irrigation system after pulling or in July for plants that are to be used for forcing.

DISEASE AND INSECT CONTROL

CROWN ROT AND VIRUS DISEASE (See Plant Selection) — Remove and destroy diseased plants. Only vigorous, normal plants should be used for propagation.

NEMATODES — See page 25.

POTATO STEM BORER — Refer to OMAF Factsheet (page 67).

RHUBARB CURCULIO — Destroy dock weeds near the rhubarb planting.

Note: The use of gibberellic acid (Activol GA) is recommended for rhubarb forcing. Recommendations may be obtained from your Crop Advisor.

RUTABAGA

For more detail, refer to OMAF Publication 502, *Rutabagas.*

CULTIVARS

Laurentian (strains)

SEED TREATMENT

Buy Registered seed that has been treated with a seed-protectant fungicide such as thiram or captan.

SEEDING AND SPACING

For the early crop (limited market) sow the seed when soil conditions allow seeding. The optimum soil temperature for germination is from 16 to 29°C.

For the main crop sow about the last two weeks in June.

Use up to 500 grams of seed per hectare. Sow 6 to 12 mm deep. Use seeders that space the seeds at known intervals, or to stand, and use seed which has been precisely sized. This will eliminate thinning and produce a highly uniform crop.

Where thinning is required, do so when plants are 4 to 8 cm high; space 15 cm apart in the row.

Rows vary from 60 to 90 cm apart.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to 35 kg N/ha. Manure may be used in the rotation at the rate of 18 to 22 t/ha but it should be applied at least a year before the rutabaga crop is grown. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

SECONDARY AND MICRONUTRIENTS — BORON DEFICIENCY — Water-core or brown heart appears first in young, enlarging roots as firm, brownish, water-soaked patches. These may increase in size until almost the whole rutabaga root is affected. Severely affected rutabagas may turn punky inside later, after storage, rather than in the field (See also Factsheet 258/690 *Brown Heart in Rutabaga.*)

BORON should be applied to the soil before sowing. The necessary quantity of boron can be mixed with the fertilizer which is applied before planting. Boron-enriched fertilizer should be applied as uniformly as possible.

Generally, foliar applications of Solubor are as effective as larger amounts applied to the soil. The first spray (foliar) application should be made when the roots of the plants are about 1.5 to 2.5 cm in diameter. The second and third applications may be applied at 10- to 14-day intervals after the first spray. Do not combine malathion, parathion, endosulfan or mevinphos with boron sprays because their effectiveness may be seriously reduced. Excessive applications of boron will often adversely affect the succeeding crop in the rotation (e.g. soybeans, snap beans, white beans and small grains). For rates and sources see page 21.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment.

BLACK ROT AND BLACKLEG — Sow Registered seed. Do not plant rutabagas, rape, kale, cabbage, and other crucifers more than once in four or five years on the same land. Do not apply manure containing rutabaga refuse or diseased rutabagas on land intended for rutabagas. Do not work in the field when plants are wet. Never store diseased rutabagas. Clean out the storage each spring.

CLUB ROOT — Use a crop rotation with non-cruciferous crops. Avoid fields known to be infested.

MOSAIC VIRUS — Losses from turnip mosaic virus are especially heavy in late plantings. Volunteer rutabagas are the main source of the virus. Aphids carry the virus to the rutabaga crop. The present insecticide spray programs do not provide satisfactory control.

Recommendations for reduction of virus

1. Virus-infected rutabagas store poorly and should be marketed as early as possible.
2. After harvest, remove as many waste rutabagas as practical from the field. Disk remaining rutabagas and leave them on the soil surface so that they are winter killed. Do not plow under rutabagas in the fall.
3. If storage culls are to be dumped, they should be left exposed to freezing weather and checked in early spring to make sure that none has survived. Kerosene or diesel fuel will help kill these rutabagas.

RUTABAGA (Continued)

4. As early in the spring as possible, volunteer rutabagas should be destroyed by spraying with a suitable herbicide, disking, or removal by hand.

NEMATODES — See page 25.

INSECT CONTROL

Check Days-to Harvest (page 60) before applying any insecticide.

ROOT MAGGOTS

Do not grow early and late rutabagas in the same field or near early cabbage and cauliflower. A number of insecticides are effective. **Each of these is highly toxic and spray operators must take full safety precautions when using and storing these chemicals.** Safe disposal of empty bags and containers is equally important.

The cabbage maggot emerges early in the year (early May) and is present in 3 or 4 generations throughout the season.

There are two distinct periods of damage: early in the season (prior to June 20) and late (after August 20). Because of this damage pattern, control of the insect must be considered in two distinct procedures, one for the early crop and one for the late.

EARLY CROP

Use one of the following granular insecticides in a 5- to 10-cm band at planting time. Cover 12 to 25 mm deep.

1. chlorfenvinfos 10% G 22.5 kg
2. fensulfothion 15% G 16 kg
3. carbofuran 10% G 25 kg

OR

Apply a drench spray in a 10- to 20-cm band over the row just prior to plant emergence. Use one of:

1. chlorfenvinfos 40% EC 4.25 L
2. fensulfothion 720 SC 3.3 L
3. carbofuran 480 F 5 L

Regardless of whether the granular or drench procedure is used for the first application, follow with a drench spray in a 10- to 20-cm band over the row 5 weeks after the first application.

Use one of:

1. [2]chlorfenvinfos 40% EC 4.25 L
2. [2]fensulfothion 720 SC 3.3 L

LATE CROP

For the first treatment use the furrow or drench application as outlined for the Early Crop.

Follow this with a second application 5 weeks later and a third application after an additional 5 weeks (mid-August) with one of the following:

1. [2]chlorfenvinfos 40% EC 4.25 L
2. [2]fensulfothion 720 SC 3.3 L

Note: All rates are for **75-cm row spacing.** For other row spacings, check label directions.

In some areas fensulfothion and carbofuran are not providing good control. Growers who experienced poor control with these insecticides should use chlorfenvinphos, as recommended in the first spray for the early crop, or spray for adults with parathion according to the label directions.

FLEA BEETLES — These insects can be controlled only in the adult beetle stage. There is no control for larvae established in roots. A spray should be applied as soon as the beetles appear in the field. Because beetles may migrate into the field over several weeks, a number of applications may be required.

If insecticide drenches are used to control root maggots, **flea beetles** will also be controlled. If these insecticides are not applied before seedling emergence and seedlings are attacked when they come up, or if beetles are numerous during the growing season, spray with one of:

1. endosulfan 50% WP 1.75 kg or 4 EC 2 L or 400 EC 2 L
2. carbaryl 50% WP 3.25 kg or 85% WP 2 kg
3. [2]carbofuran 480 F 1.1 L
4. permethrin 500 EC 140 mL (before 8-leaf stage)

APHIDS — If the crop is threatened, spray with one of the following insecticides. These insecticides are not likely to be effective against aphids if combined with boron sprays.

1. malathion 25% WP 4.5 kg
2. [3]parathion 800 EC 400-700 mL
3. endosulfan 50% WP 1.75 kg or 4 EC 2 L or 400 EC 2 L
4. dimethoate 480 E 0.7 L

LEAF-EATING CATERPILLARS — If cabbageworms, cabbage loopers, zebra caterpillars, etc., are numerous, spray with one of:

1. ***Bacillus thuringiensis* 0.5-1.1 kg or 2.25-4.5 L (use higher rates for looper control)
2. endosulfan 50% WP 1.75 kg or 4 EC 2 L or 400 EC 2 L

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[1] *Minimum period before reentry is 24 hours.*

[2] *Minimum period before reentry is 48 hours.*

[3] *Minimum period before reentry is 7 days.*

***See "Temporary Registration of Pesticides" inside front cover.*

DAYS TO HARVEST FOR PESTICIDES USED ON RUTABAGAS

Pesticide	Number of days between last application and harvesting for human consumption or feeding to livestock
chlorfenvinfos	40
fensulfothion	40
Bacillus thuringiensis	0
dimethoate	7*
carbofuran	40
malathion	10
mevinphos	1
parathion	21**
carbaryl	14
endosulfan	45***

* *For tops only.*

** *15 days if tops are not to be used for food or feed.*

****Do not feed the tops or trimmings to livestock.*

HARVESTING AND WASHING

Avoid bruising. Damaged and bruised rutabagas are likely to rot and do not store well.

Dirty water contains large numbers of rot-causing organisms. To reduce loss from disease after waxing, change water in the wash tank frequently or add fresh water continuously to keep water as clean as possible. Then spray-rinse rutabagas with clean water and dry them as rapidly as possible before waxing or shipping. Trimming after washing helps reduce rot in waxed rutabagas.

RUTABAGA (Continued)

STORAGE

Clean the storage thoroughly in the spring. To disinfect the storage, spray all surfaces with a mixture of copper sulfate (bluestone) 1 kg, hydrated lime 2 kg, dissolved in 50 litres of water. Add lime last. Since this mixture is corrosive to metals, cover metal fixtures such as fans, electrical control equipment, etc. during the spraying operation. An alternative disinfectant spray is a 1:240 solution of formaldehyde. Follow all cautions.

Do not spread refuse from the storage on land that may be used for rutabagas.

Never put diseased rutabagas in storage. Disease-free rutabagas will keep up to 6 months if stored at 0°C and a relative humidity of 90 to 95%. Adequate ventilation and air movement throughout the storage are necessary.

To inhibit sprouting in storage, apply maleic hydrazide about 4 to 6 weeks before harvest according to manufacturer's directions.

Do Not Feed Vegetables Treated With Endosulfan to Livestock or Poultry

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SPINACH

CULTIVARS

(not revised for 1986)

Mineral Soil

Long Standing Bloomsdale (spring)
Dixie Market (spring; mildew resistant)
America (spring and summer)
Viking (smooth-leafed; spring and summer)
Virginia Savoy (fall and overwintering)

Muck Soil

(tolerant to bolting)

Wobli	1*
Tarantella	3
Mazurka	1
Norveto	3
Estivato	2
Symphony	1
Melody	2

**1 = smooth leaf; 2 = medium leaf; 3 = savoyed leaf*

BOLTING

Spinach quickly bolts (produces flowerstalks) under long-day and warm-weather conditions. This explains why the crop is produced mostly in the spring or fall. Cool weather reduces the long-day effect. Spinach grown in cool summers may not bolt quickly.

Bolting may also be hereditary. Strains of spinach deteriorate in quality if the seed producer allows the quick-bolting types to increase.

SEED TREATMENT

Treat seed with a thiram or captan seed protectant.

SEEDING AND SPACING

Sow outside as soon as soil can be worked in early spring until early May; or from July 31 to August 31 for a fall crop. Do not sow seed in midsummer because bolting may occur. For overwintered spinach, sow from September 1 to 10. About 12 kg of seed will plant one hectare.

Fresh seed will germinate readily at soil temperatures as low as 3 to 4°C, and good results are obtained at 10 to 16°C. At higher temperatures there is a more rapid emergence, but decreased percentage germination. The ability to germinate in cool soil permits very early sowing in spring.

Spinach seed more than a year old rarely germinates over 80%. Older seed is even less viable and germinates more slowly and irregularly.

Space rows 30 cm apart, and plants 5 to 10 cm in the row.

SOIL

Sandy soils are preferred for the early and over-wintered crops. The highest yields are obtained on muck soils. Muck soils have a high water-holding capacity, but are well-aerated. From such soils the harvested crop contains a minimum of sand or other gritty material. Since spinach is somewhat sensitive to soil acidity, a test should be made before planting the crop.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply 55 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. (See tables on pages 14 and 16).

APPLICATION — On MINERAL SOILS for a very early planting, all of the nitrogen may be applied at planting time.

For a midseason or later crop, apply half the recommended amount of nitrogen at planting time.

Side-dress the midseason or late crop with 55 kg N/ha following excessive rainfall, especially on sandy soils.

On MUCK SOILS, although the recommended amount of nitrogen should normally be considered maximum, it may be permissible following excessive rainfall to side-dress with an additional 55 kg N/ha.

SECONDARY AND MICRONUTRIENTS — MANGANESE deficiency may be corrected by spraying with manganese sulfate (see page 21).

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment.

DOWNY MILDEW AND MOSAIC — Grow a resistant cultivar. Do not grow a fall crop in, or adjacent to, a field where an infected spring crop was grown.

SPINACH (Continued)

FUSARIUM WILT AND ROOT ROT — In soils where this disease is a problem, do not seed spinach between May 31 and August 15.

NEMATODES — To avoid damage from sugar-beet nematode, do not plant spinach following rhubarb, beets or spinach.

INSECT CONTROL

LEAF MINER — Spray when mines first appear. Use one of:

1. [3]parathion 15% WP 2.25 kg or 960 E 350 mL (7 days)
2. malathion 25% WP 5.5 kg or 500 EC 2.5 L (7 days)
3. diazinon 50% WP 1.1 kg or 500 EC 1.1 L (10 days)

APHIDS — Use one of:

1. endosulfan 50% WP 1.75 kg or 4 EC 2 L (14 days). Make only one application.
2. diazinon 50% WP 1.1 kg or 500 EC 1.1 L (10 days)
3. [3]parathion 15% WP 2.25 kg or 960 E 350 mL (7 days)
4. dimethoate 480 E 0.7 L (7 days)

CABBAGE LOOPER — Use one of:

1. ***Bacillus thuringiensis* HPC 4.5 L or 1.1 kg (0 days)
2. endosulfan 50% WP 1.75 kg or 4 EC 2 L (14 days). Make only one application.
3. [3]parathion 15% WP 2.25 kg or 960 E 350 mL (7 days)

Note: Materials recommended for looper control are much more effective against small larvae. Direct spray to both upper and lower leaf surfaces. Repeat in 7 days.

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[3] *Minimum period before reentry is 7 days.*

***See "Temporary Registration of Pesticides" inside front cover.*

TOMATO

CULTIVARS FOR CLIMATIC ZONES IN ONTARIO

FRESH MARKET	ZONES (See Fig. 1, page 9)		HOME PROCESSING (PYO)
Cultivars (in order of maturity)	A & B	C, D & E	**Cultivars** (in order of maturity)
New Yorker	X	X	TH 318
Springset	X	X	H 2653
Basketvee		X	FM 6203
Baron*		X	Ohio 7814
Pik Red*	X	X	Ohio 832
Fresh Pak*	X	X	Veepick
Jackpot*	X		H-722
Jetstar*		X	

X indicates suitability of cultivars in each zone.

* *Cultivars suitable for shipping*

CULTIVARS FOR COMMERCIAL PROCESSING — Follow processors' requirements.

CULTIVAR DESCRIPTIONS

Fresh Market

New Yorker — Verticillium resistant, very early, small plant, small-fruited, soft. Acceptable as a first-early fresh-market cultivar.

Springset — Verticillium resistant, F_1 hybrid, very early, small plant, medium-sized fruit. Slightly later than New Yorker with slightly better fruit quality.

Basketvee — Verticillium resistant, early-midseason, medium to large-sized fruit. Good quality for shipping when well grown.

Baron — Verticillium resistant, F_1 hybrid, midseason, compact plant, jointless, dark green shoulder. Fruit size is slightly smaller than Pik Red but very firm.

Pik Red — Verticillium resistant, F_1 hybrid, midseason, large, very firm globe-shaped fruit, dark green shoulder, excellent shipper. Excessive nitrogen may promote cracking and yellow top.

Fresh Pak — Verticillium resistant, F_1 hybrid, midseason, large firm globe-shaped fruit, dark green shoulder. Better foliage cover than Pik Red. Excessive nitrogen may promote cracking and yellow top.

Jackpot — Verticillium resistant, F_1 hybrid, midseason, large firm globe-shaped fruit, light green shoulder.

Jetstar — Verticillium resistant, F_1 hybrid, midseason, large flattened globe fruit. Suitable for staking.

Home Processing

TH 318 — Early, compact open plant, variable fruit size, depending on conditions, generally good fruit quality. Additional nitrogen may be necessary.

H 2653 — Verticillium resistant, early compact plant, small plum-shaped fruit, excellent concentration of maturity. Additional nitrogen may be necessary.

FM 6203 — Verticillium resistant, midseason, medium-sized square-round fruit with excellent firmness.

Ohio 7814 — Verticillium resistant, midseason, medium-sized plum-shaped fruit, well colored and firm, very productive, excellent for wholepack.

Ohio 832 — Verticillium resistant, midseason, medium-sized plum-shaped fruit, excellent firmness and color. Possible replacement for Chico III and C37.

Veepick — Verticillium resistant, large pear-shaped fruit with good flavor, good yields. Well suited for PYO.

H 722 — Verticillium resistant, late, small plum-shaped fruit, excellent yield, concentration of maturity and field storage.

Note: All cultivars have determinate (bush type) growth and uniform green shoulders unless otherwise noted.

TOMATO (Continued)

SEED TREATMENT

Sow hot-water-treated seed (page 26). Treat dry seed with thiram seed protectant.

GROWING THE PLANTS

Since tomatoes require a relatively long growing season, they should be started in a greenhouse or hotbed. Sow seeds at a rate of 8 seeds per 25 mm at a depth of 6 mm in shallow flats about 8 weeks before field transplanting. A temperature of about 27°C for 1 to 2 weeks is required for good seed emergence.

When the seedlings are approximately 4 cm high or when the first true leaves appear, transplant them into other flats containing a fertile compost soil. The plants should be spaced 5 to 7 cm apart. Seedlings can also be transplanted into clay or peat pots or to veneer or paper bands.

Tomato plants can also be raised by sowing raw seed directly into peat pots, multi-pot trays, speedling flats or directly into beds filled with special growing media. Under such a planting system, usually a superior plant can be raised in a shorter time. This system is less labor intensive and reduces transplant shock.

Growing-media information can be obtained from OMAF Publication 365 or from your local Crop Advisor. Under no circumstances should large amounts of fresh manure or mushroom compost be added to a soil or soil-less mix as a dangerously high salt level in the growing medium will result in stunting, poor germination and death of young tomato plants. Where the salt level is in question, growing media should be analysed prior to planting.

Tomato plants should be hardened for about one week before transplanting to the field. This can be accomplished by reducing the soil moisture supply, and reducing the air temperature to 13-16°C. Hardening-off improves the survivability of the plants to adverse weather conditions when field-set.

TRANSPLANTS

Use only plants which are disease-free and well grown. Sturdy slowly-grown plants are best. Recovery of severely hardened plants is slow and never complete. Plants of early-maturing, highly determinate cultivars should be relatively young and free from blossoms or visible blossom buds. Late cultivars are transplanted earlier than highly determinate cultivars, as growing conditions are usually less favorable early in the season.

TRANSPLANT STORAGE

Adverse weather conditions often disrupt field transplanting, forcing storage of crated, southern transplants. The following storage practices will assist in maintaining a high plant-survival rate.

1. Open and check all crates to see that plants are dry and in good condition; remove moldy bundles.
2. Store plants in a sheltered area (open sheds or barns); avoid hot dry winds.
3. Keep foliage of plants dry; never sprinkle water on foliage during storage.
4. Avoid exposing the crates to temperatures above 10 to 12°C.
5. Do not hold transplants longer than 10 days.

DIRECT SEEDING

Select fields that have a low to medium weed-population pressure. This factor combined with early and precise cultivation after emergence will make weed control more effective.

Prepare a seedbed that is shallow and retains soil moisture as close to the soil surface as possible. Seed at 600 to 1100 grams per hectare (30 to 65 seeds per metre of row) or sow 4 to 6 seeds per clump every 20 to 30 cm. With clump seeding, place an anticrustant (vermiculite) above the seed clump for better seedling emergence.

Use early to mid-season cultivars with compact plant type. Sow from early May to May 25 for mid to late September harvest. Sow seed into moist soil as shallow as possible to achieve quick and uniform emergence. Thin seedlings at the 2nd to 4th true-leaf stage to a stand with plants 22 to 30 cm apart.

SEEDING AND SPACING

Approximately 75 to 150 grams of seed are required to produce enough plants for one hectare.

RECOMMENDED PLANT SPACING

		Processing		
	Fresh Market	**Machine-Harvest**		**Handpick**
		Single Row	**Twin Row**	
Rows:	1.2 m	1.5 m	1.5 to 1.65 m	1.2 to 1.5 m
Plants:	30-45 cm	30 cm	45 x (30-45) cm	36 to 60 cm

NOTE: **Twin-row spacing** may enhance production. Consult your area Crop Advisor or processor field representative.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. (See tables on pages 21 and 22).

NITROGEN — Apply up to a maximum of 90 kg N/ha.

APPLICATION — For some early, poor-vigor cultivars such as H2653 and TH318 apply 65 kg N/ha broadcast and sidedress 25 kg N/ha 3 weeks after transplanting. Never sidedress later than 4 weeks after transplanting. On sandy soils with low organic matter, following excessive rainfall, sidedress with an additional 20 kg N/ha. Sidedressing too late may delay harvest and reduce Ethrel response.

For direct-seeded processing tomatoes apply 25% less nitrogen. If direct-seeded tomatoes are sidedressed they should receive this sidedressing 4 weeks after plants emerge from the soil.

STARTER SOLUTION — (ALL TOMATOES) — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high-temperature conditions or in dry sandy soils reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

TOMATO (Continued)

DISEASE CONTROL

A. **IN THE SEEDBED**

1. Sow only hot-water-treated seed. (See page 26).
2. Treat seed with thiram. See Seed Treatment.
3. Steam or fumigate the soil with Vorlex, dazomet, or methyl bromide*.
4. Disinfect all greenhouse walls, benches and equipment.
5. Avoid unnecessary movement through the plants.
6. Immediately after sowing or transplanting, drench soil with captan 50% WP or 80% WP (see label).
7. When first true leaves develop, spray with one of the copper bactericides tank mixed with either mancozeb or maneb at 11 g product per 50 m^2. Repeat spray every 7 to 10 days.

* *A permit issued by the Ontario Ministry of the Environment is required to use methyl bromide.*

B. **IN THE FIELD**

BACTERIAL SPOT, BACTERIAL SPECK, BACTERIAL CANKER — It is not possible to completely control tomato bacterial diseases with chemical sprays. A reduction of foliar and sometimes fruit lesions can be achieved by early spring applications of either mancozeb or maneb at 2.25 kg product per hectare tank-mixed with one of the copper bactericides. Avoid copper settling-out problems by thorough spray-tank agitation and by spraying soon after mixing. Many tomato cultivars possess a level of field resistance and are not damaged, even though disease lesions on the leaves are noticeable. Foliar chemical sprays for these field-resistant cultivars are not required. Consult your processor fieldman, Crop Advisor, or Pest Management Specialist. For those relatively few tomato cultivars that are highly susceptible, chemical control measures should begin 2 to 3 weeks after transplanting and repeated when necessary up to July 1. After this approximate date, spraying for bacterial disease control is not recommended.

ANTHRACNOSE, EARLY BLIGHT, LATE BLIGHT — Spray when first fruits are about walnut size (or when first fruits appear on early cultivars). Repeat sprays as necessary. During continuously moist weather, intervals should be 5 to 7 days. In warm dry weather, intervals can be extended to 12 to 14 days if diseases are under control. For anthracnose, continue spraying until mid-September.

Use one of:

1. captafol 480 F 2.75 L (1 day) See label precautions.
2. chlorothalonil 500 2.4-4 L (1 day) (Under heavy disease pressure, use higher rate).
3. mancozeb 80 WP 3.25 kg (1 day)
4. maneb 80% WP 3.25 kg (3 days)
5. metiram 80W 3.25 kg (1 day)

SEPTORIA LEAF SPOT — Spray as above with one of:

1. chlorothalonil 500 3.2-4 L (1 day)
2. fixed copper 3.25 kg (active ingredient) (1 day)
3. captafol 480 F 2.75 L (1 day). See label precautions.

BACTERIAL CANKER, SOUTHERN BACTERIAL WILT — There are no practical control measures once detected under field conditions. These diseases are not readily spread throughout a field under dry weather conditions. Avoid working in tomato fields when foliage is wet.

FUSARIUM WILT, VERTICILLIUM WILT — Crop rotation is recommended. Grow Fusarium and Verticillium-wilt resistant cultivars if suited to area and market.

VIRUS DISEASES (MOSAIC, STREAK, GRAY WALL) — Grow seedlings in steamed soil in greenhouses and frames devoted to tomato seedlings only. Control aphids in seedbeds. Do not handle tobacco in any form when handling plants. Wash hands with soap and water before handling tomato plants. Do not harden transplants by leaving them in headlands or other weedy places. Cultivators should not be used in a healthy crop after use in an infected crop.

BLOSSOM-END ROT — This disorder is not caused by a disease organism. It is associated with calcium deficiences in the plant and/or moisture stress (due to drought or excessive fertilizer use). The disorder may be reduced by maintaining uniform soil moisture (see Irrigation, page 23), and by avoiding close, deep cultivation when plants are large.

NEMATODES — See page 25.

INSECT CONTROL

VARIEGATED CUTWORMS — Chemical control is obtained only when insects come in contact with the insecticide. Control is therefore related to how effective the spray coverage is on the larvae. Early detection and control are essential, as larger insects are more difficult to control.

Spray with one of:

1. permethrin 500 EC 140 mL (1 day)
2. methomyl L 1.1-2.25 L (1 day). If numerous large larvae (2.5-3 cm) are found, use the higher rate.
3. carbaryl XLR 1.25 L or 50 W 4.5 kg or 85% W 2.5 kg (1 day)

FLEA BEETLES — Before field setting, spray with carbaryl 50% WP 60 grams or 85% WP 45 grams in 25 L of water. If a spray in the field is required, use one of the following in 1000 L of water:

1. carbaryl XLR 1.25 L or 50% WP 2.25 kg or 85% WP 1.25 kg (1 day)
2. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L or 400 EC 2.75 L (2 days)
3. permethrin 500 EC 200 mL (1 day)
4. [2]azinphos-methyl 240 SC 2.25 L or 50% WP 1.5 kg (2 days)

APHIDS — Control needed infrequently. Spray with one of:

1. diazinon 50% WP 1-1.75 kg or 500 EC 1.1-2 L (1 day)
2. dimethoate 480 E 550-700 mL (7 days)
3. malathion 500 EC 1.25 L (3 days). Not effective below 18°C.
4. [2]demeton 240 SC 1.75 L (3 days)
5. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L (2 days)
6. [1]methomyl L 1.25-2.25 L (1 day)

Good spray coverage is required for aphid control. Repeated spray applications may be required when weather conditions favor rapid build-up of aphids. The two types of aphids affecting tomatoes are the potato aphid and the green peach aphid, the latter being more difficult to control.

TOMATO (Continued)

COLORADO POTATO BEETLE — Spray with one of the following and repeat as necessary:

1. [2]azinphos-methyl 240 SC 1.75 L or 50% WP 0.85 kg (2 days)
2. permethrin 500 EC 200 mL (1 day)
3. carbaryl 50% WP 1.1 kg (1 day) (only effective on larval stages)

HORNWORMS — If hornworms are present, spray with one of:

1. permethrin 500 EC 200 mL (1 day)
2. carbaryl 50% WP 3.25 kg or 85% WP 2 kg (1 day)
3. endosulfan 50% WP 1.1 kg or 4 EC 1.4 L (2 days)
4. ***Bacillus thuringiensis* HPC 725 mL-1.5 L or 275-550 g (0 days)
5. [2]azinphos-methyl 240 SC 2.25 L or 50% WP 0.85 kg (2 days)

DROSOPHILA (fruit fly) — In the field — apply one of:

1. diazinon 50% WP 1.75 kg (1 day)
2. naled 8.64 EC 1.1 L (4 days)
3. [2]azinphos-methyl 240 SC 2.25 L or 50% WP 0.85 kg (2 days)

Picked fruit — Spray or dust fruit and containers with a commercial mixture containing pyrethrins and piperonyl butoxide at rates given on the label. This spray or dust is permitted on all types of tomatoes.

CABBAGE LOOPERS — If cabbage loopers are a problem, spray with ***Bacillus thuringiensis* HPC 4.25 L or 1.1 kg (0 days). This material is much more effective against small larvae.

SAP BEETLES — Since there is no suitable insecticide to control sap beetles in the field, practise the following cultural controls to reduce the incidence of sap beetles in the fruit:

1. Leave roadways in the field at suitable intervals to allow movement of farm vehicles without squashing fruit.
2. Minimize crushing and squashing of fruit at picking time.
3. Pick as close as possible to time of delivery to the factory.
4. If loaded wagons are not delivered immediately, leave them exposed to air circulation rather than in a protected area.

GRASSHOPPERS AND CRICKETS — Maintain weed-free borders and fencerows. If these insects are a problem, spray around the edge of the field with [2]azinphos-methyl 240 SC 2.25 L (2 days).

RING-BILLED GULL CONTROL

Ring-billed gull populations are increasing and are moving further inland along the shores of Lake Erie and Ontario. Tomato fruits are damaged by the repeated feeding scars, resulting in reduced yields and quality, and increased sorting costs. Overall population control is not feasible; however, growers wishing to protect areas within a field can obtain a licence to shoot gulls. Early gull detection and control are important. For a permit, call the Enforcement Co-ordinator, Canadian Wildlife Service, Ontario Region, 152 Newbold Court, London, Ontario. (519) 681-0486.

CHEMICAL FRUIT RIPENING

Use ethephon (Ethrel) for uniform ripening for once-over harvest and to enhance ripening in the late cultivars or during late seasons. For best results ethephon should be applied to fields in good condition; plants which are stressed (wilted or damaged by disease or insects) will not respond satisfactorily.

Ethephon is effective only on fruits that are mature green (i.e. when cutting fruit with a sharp knife, seeds should remain uninjured, protected by a gelatinous pulp). With most processing cultivars the time of application is when the maximum number of fruit has reached the mature green stage; this occurs when 5 to 20% of the fruit is showing red color development. Good spray coverage on fruit and foliage is essential for maximum effectiveness. Use 3.75 to 7.50 L in 500 to 1000 L of water per hectare. Use higher rates when day temperatures are below 18°C and also when plant growth is dense. If plants are under stress, avoid use of ethephon or apply it at reduced rates. Excessive rates of ethephon will cause defoliation which will result in reduced fruit quality. Cool temperatures will delay color development, and extend period between treatment and harvest. Generally, fruit is ready to harvest 14 to 21 days after treatment.

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[1] *Minimum period before reentry is 24 hours.*

[2] *Minimum period before reentry is 48 hours.*

***See "Temporary Registration of Pesticides" inside front cover.*

PESTICIDES-CONTROL FIELD OFFICES

ONTARIO MINISTRY OF THE ENVIRONMENT

Counties	Field Offices	Telephone
Central Region		
Halton, Peel, York, Durham, Toronto	T. O'Neill & D. Trenholm 7 Overlea Blvd., Don Mills M4H 1A8	416-424-3000 (ext. 211)
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George Street N., Peterborough K9J 3G6	705-743-2972
Simcoe, Muskoka	W. Cowie 12 Fairview Road, Barrie L4N 4P3	705-726-1730
West Central Region		
Haldimand-Norfolk, Niagara, Hamilton-Wentworth	J. Percy Ont. Gov't Bldg., 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Dufferin, Wellington, Waterloo, Brant	R. Miller Ont. Gov't. Bldg., 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Southwestern Region		
Elgin, Middlesex, Oxford	D.C. Morrow & W. Lampman 985 Adelaide Street South, London N6E 1V3	519-661-2200
Essex, Kent, Lambton	H.E. Collins P.O. Box 726, 435 Grand Avenue W. Chatham N7M 5L1	519-354-2150
Bruce, Grey, Huron, Perth	B.T. Lobb 20 King Street, P.O. Box 688 Ont. Ministry of Agr. & Food Bldg. Clinton N0M 1L0	519-482-3428
Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Granville	D.A. Raddon 133 Dalton St., Kingston K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury	D.J. Mewett Northgate Shopping Centre, 1500 Fisher St., North Bay P1B 2H3	705-476-1001
Cochrane, Timiskaming, Algoma	P. McCubbin 199 Larch St., Sudbury P3E 5P9	705-675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Building, 435 James St. S. Thunder Bay P7C 5G6	807-475-1215
Head Office	Agricultural and Industrial Chemicals Section 135 St. Clair Avenue W., Suite 100 Toronto, M4V 1P5	416-965-2401

PUBLICATIONS — The following publications are available from any of the Pesticide Control Field offices or from Agricultural and Industrial Chemicals Section, Suite 100, Ministry of the Environment, 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5:

- Personal Protective Equipment for Pesticide Users
- Chemical Safety Handbook
- Pesticides Act and Regulations
- Chemical-Storage Signs

ACKNOWLEDGMENTS

The recommendations contained in this publication have been prepared in consultation with:

- Ontario Crop Protection Committee
- Ontario Horticultural Crops Research Committee
- Ontario Soil Management Research Committee
- Ontario Weed Committee

and the personnel of:

- Plant Industry Branch, Ontario Ministry of Agriculture and Food
- Agriculture Canada
- Horticultural Research Institute of Ontario
- Ontario Agricultural College, University of Guelph
- Kemptville and Ridgetown Colleges of Agricultural Technology
- Ontario Ministry of the Environment
- Ontario Ministry of Labour
- Health and Welfare Canada

ABBREVIATIONS

EC = emulsifiable concentrate
WP = wettable powder
F = flowable
E = emulsion
SC = spray concentrate
SP = soluble powder
G = granules or granular
°C = degrees Celsius
AP = agricultural powder
W = wettable (powder)
L = liquid

g = gram
m = metre
cm = centimetre
ha = hectare
mL = millilitre
t = tonne
kg = kilogram
km = kilometre
mm = millimetre
L = litre
hL = hectolitre
kPa = kilopascal

PUBLICATIONS FOR VEGETABLE GROWERS

MINISTRY OF AGRICULTURE AND FOOD PUBLICATIONS

Publications available from Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5, or from the Crop Advisor or Pest Management Specialist serving your area.

NUMBERED PUBLICATIONS

40	Greenhouses
63	Farm Roadside Marketing in Ontario
75	Guide to Chemical Weed Control
284	Ontario Farm Record Book
365	Greenhouse Vegetable Production Recommendations
485	Growing Vegetable Transplants
486	Onions
501	Farm Drainage
502	Rutabagas
505	Ontario Weeds (from Communications Branch — $2.50)
515	Farm Ponds
534	Potato Production in Ontario
—	Catalogue of Plans for Fruit and Vegetable Buildings and Equipment

FACTSHEETS

110/622	Armyworm
111/622	European Corn Borer
111/622	Potato Stem Borer in Ontario
111/632	Head Smut of Corn
111/685	Bird Damage to Corn
161/635	Black Scurf and Silver Scurf of Potatoes
161/635	Dry Rots of Potatoes in Storage
161/635	Ring Rot of Potato
161/745	Reducing Mechanical Injury in Potato Handling
200/545	Metal Chelates in Horticulture
200/691	Air Pollution and Horticultural Crops
202/51	Pick-Your-Own Harvesting
202/65	Storage Incompatibility
202/744	Improving Spray Coverage on Row Crops
210/744	Application Technique with Air-Blast Sprayers
250/22	High-Density Planting of Vegetable Crops
250/23	Vegetable Seed Treatments

FACTSHEETS (Continued)

250/23	Precision Seeding Vegetable Crops
250/24	Polyethylene Mulches in Vegetable Production
250/26	Pollination of Vegetable Crops
250/65	Sprout Inhibition of Stored Vegetables
250/541	Starter Solutions for Vegetable Crops
250/560	Irrigation of Vegetables in Southern Ontario
252/64	Storage of Cabbage
252/612	Cabbage Loopers
252/612	Cabbageworm
252/635	Bacterial Leaf Spot of Cauliflower
252/690	Hollow Stem in Broccoli
254/13	Commercial Asparagus Production
254/13	Growing Rhubarb
254/57	Maintaining Asparagus Quality from Producer to Consumer
255/20	Peas for Processing
255/630	Fungal Diseases of Field and Snap Beans
256/07	Sex Expression in Cucumbers
256/20	Growing Pickling Cucumbers
256/51	Mechanical Harvesting of Cucumbers
256/635	Angular Leaf-Spot of Cucumber
257/13	Growing Peppers
257/21	Production of Potatoes for Processing
257/22	Field Seeding of Tomatoes
257/28	Growing Potatoes from True Seed
257/635	Virus Diseases of Tomato and Pepper
257/635	Bacterial Speck of Tomato
257/635	Late Blight of Potatoes
257/635	Black Heart and Jelly End-Rot of Potatoes
257/635	Blackleg of Potatoes
257/690	Tomato Fruit Disorders
258/13	Baby Carrot Production
258/13	Garlic
258/13	Horseradish
258/20	Sweet Potatoes
258/55	Onion Drying
258/64	Storing Rutabagas
258/64	Storage of Carrots
258/605	Carrot Insects
258/605	Onion Maggot Control in Dry Onions
258/628	Bulb and Stem Nematode in Onions
258/635	Onion Neck Rot
258/635	Field Diseases of Onions
258/635	Virus Diseases of Rutabagas
258/635	Weather-Timed Sprays for Carrot Blight Control
258/732	Artificial Curing of Onions
258/690	Brown Heart in Rutabaga
291/635	Bacterial Canker of Tomato
296/510	Soilless Mixes
512	Management of Organic Soils
534	Soil Acidity and Liming
553	Maintenance of the Drainage System
555	Drainage Benefits
562	Irrigation Water Supply
572	Soil Erosion — Causes and Effects
573	Grassed Waterways
606	Soil Fumigants
607	Pesticide Drift
607	Farm Storage of Pesticides
607	Safe Use of Granular Pesticides
607	Pesticide Contamination of Farm Water Supplies
607	Protective Clothing When Using Pesticides Outdoors
610	Slugs
628	Nematode Control — Guidelines
628	Soil & Roots for Nematode Analysis
675	Earwigs
675	Sap Beetles
705	Fertilizer in Kilograms and Tonnes
707	Homemade Hygrometers
707	Measuring Relative Humidity (RH)

AGRICULUTRE CANADA PUBLICATIONS

Publications available from Information Services, Agriculture Canada, Ottawa, K1A 0C7.

868	Manures and Compost
1058	Potatoes
1083	Soil Erosion by Water
1158	Growing Savory Herbs
1266	Soil Erosion by Wind
1337	How to Build a Plastic Crop Shelter or Greenhouse
1355	Growing Rutabagas
1479	Tomato Diseases
1482	Field Sprayers
1492	Diseases and Pests of Potatoes
1508	Bulk Potato Storage
1558	Growing Garden Tomatoes
1559	Growing Garden Potatoes
1664	Rhubarb Culture
1681	Composting
1684	Cucumber Diseases

MINISTRY OF THE ENVIRONMENT PUBLICATIONS —
See page 66.

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight — Volume Equivalents

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry — Liquid Equivalents

1 cm^3 = mL
1 m^3 = 1000 L

APPLICATION RATE CONVERSIONS

Metric to Imperial (Approximate)

litres per hectare x 0.09 = gallons per acre
litres per hectare x 0.36 = quarts per acre
litres per hectare x 0.71 = pints per acre
millilitres per hectare x 0.015 = fluid ounces per acre
grams per hectare x 0.015 = ounces per acre
kilograms per hectare x 0.89 = pounds per acre
tonnes per hectare x 0.45 = tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23 = litres per hectare (L/ha)
quarts per acre x 2.8 = litres per hectare (L/ha)
pints per acre x 1.4 = litres per hectare (L/ha)
fluid ounces per acre x 70 = millilitres per hectare (mL/ha)
tons per acre x 2.24 = tonnes per hectare (t/ha)
pounds per acre x 1.12 = kilograms per hectare (kg/ha)
ounces per acre x 70 = grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLES

METRIC TO IMPERIAL

Length
1 millimetre (mm) = 0.04 inch
1 centimetre (cm) = 0.40 inch
1 metre (m) = 39.40 inches
1 metre (m) = 3.28 feet
1 metre (m) = 1.09 yards
1 kilometre = 0.62 mile

Volume (liquid)
1 millilitre (mL) = 0.035 fluid ounce
1 litre (L) = 1.76 pints
1 litre (L) = 0.88 quart
1 litre (L) = 0.22 gallon (Imperial)
1 litre (L) = 0.26 gallon (U.S.)

Weight
1 gram (g) = 0.035 ounce
1 kilogram (kg) = 2.21 pounds
1 tonne (t) = 1.10 short tons
1 tonne (t) = 2205 pounds

Pressure
1 kilopascal (kPa) = 0.15 pounds/square inch

Proportion
1 litre per hectare = 14.24 fluid ounces per acre
1 kilogram per hectare = 14.50 ounces avdp per acre
1 kilogram per square centimetre = 14.23 pounds per square inch
1 hectolitre per hectare = 1.10 bushels per acre

Area
1 square centimetre (cm^2) = 0.16 square inch
1 square metre (m^2) = 10.77 square feet
1 square metre (m^2) = 1.20 square yards
1 square kilometre (km^2) = 0.39 square mile
1 hectare (ha) = 107,636 square feet
1 hectare (ha) = 2.5 acres

Volume (dry)
1 cubic centimetre (cm^3) = 0.061 cubic inch
1 cubic metre (m^3) = 1.31 cubic yards
1 cubic metre (m^3) = 35.31 cubic feet
1000 cubic metres (m^3) = 0.81 acre-foot
1 hectolitre (hL) = 2.8 bushels

Speed
1 metre per second = 3.28 feet per second
1 metre per second = 2.24 miles per hour
1 kilometre per hour = 0.62 mile per hour

Temperature
$°F = (°C \times 9/5) + 32$
$°C = (°F - 32) \times 5/9$

IMPERIAL TO METRIC

Length
inch = 2.54 cm
foot = 0.30 m
yard = 0.91 m
mile = 1.61 km

Area
square foot = 0.09 m^2
square yard = 0.84 m^2
acre = 0.40 ha

Weight
ounce = 28.35 g
pound = 453.6 g
ton = 0.91 tonne

Volume (dry)
cubic yard = 0.76 m^3
bushel = 36.37 L

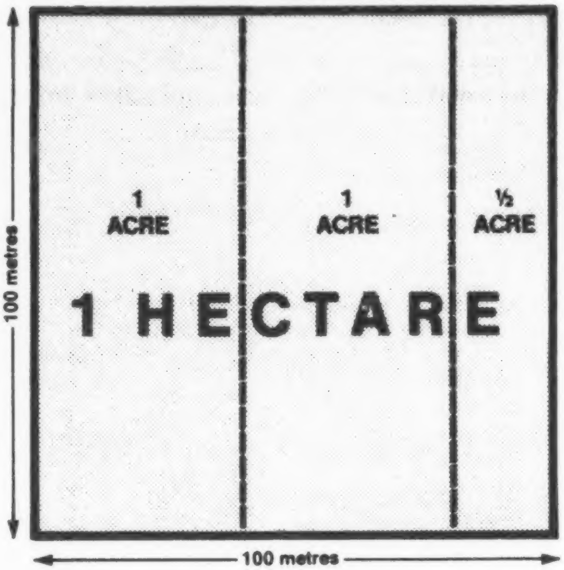
Volume (liquid)
fluid ounce (Imp.) = 28.41 mL
pint (Imp.) = 0.57 L
gallon (Imp.) = 4.55 L
gallon (U.S) = 3.79 L

Pressure
pound per square inch = 6.90 kPa

ACRES BECOME HECTARES

ACRES TO HECTARES

1 acre = 0.4 hectares
2 acres = 0.8 hectares
3 acres = 1.2 hectares
4 acres = 1.6 hectares
5 acres = 2.0 hectares
6 acres = 2.4 hectares
7 acres = 2.8 hectares
8 acres = 3.2 hectares
9 acres = 3.6 hectares
10 acres = 4.0 hectares
20 acres = 8.0 hectares
30 acres = 12.0 hectares
40 acres = 16.0 hectares
50 acres = 20.0 hectares
60 acres = 24.0 hectares
70 acres = 28.0 hectares
80 acres = 32.0 hectares
90 acres = 36.0 hectares
100 acres = 40.0 hectares



100 m x 100 m = 10,000 m² = 1 hectare (ha)

HECTARES TO ACRES

1 hectare = 2.5 acres
2 hectares = 5.0 acres
3 hectares = 7.4 acres
4 hectares = 10.0 acres
5 hectares = 12.4 acres
6 hectares = 15.0 acres
7 hectares = 17.3 acres
8 hectares = 20.0 acres
9 hectares = 22.2 acres
10 hectares = 25.0 acres
20 hectares = 50.0 acres
30 hectares = 74.0 acres
40 hectares = 100.0 acres
50 hectares = 123.5 acres

METRIC APPLICATION RATES WITH AN ACRE PERSPECTIVE

Dry Weight

10 g/ha = 4 g/acre
20 g/ha = 8 g/acre
30 g/ha = 12 g/acre
40 g/ha = 16 g/acre
50 g/ha = 20 g/acre
100 g/ha = 40 g/acre
500 g/ha = 200 g/acre
1000 g/ha = 400 g/acre
1 kg/ha = 400 g/acre (0.4 kg/acre)
2 kg/ha = 800 g/acre (0.8 kg/acre)
3 kg/ha = 1.2 kg/acre
4 kg/ha = 1.6 kg/acre
5 kg/ha = 2 kg/acre
10 kg/ha = 4 kg/acre
20 kg/ha = 8 kg/acre
30 kg/ha = 12 kg/acre
40 kg/ha = 16 kg/acre
50 kg/ha = 20 kg/acre
100 kg/ha = 40 kg/acre
500 kg/ha = 200 kg/acre
1000 kg/ha = 400 kg/acre
1 tonne/ha = 400 kg/acre

Liquid Volume

10 mL/ha = 4 mL/acre
20 mL/ha = 8 mL/acre
30 mL/ha = 12 mL/acre
40 mL/ha = 16 mL/acre
50 mL/ha = 20 mL/acre
100 mL/ha = 40 mL/acre
500 mL/ha = 200 mL/acre
1000 mL/ha = 400 mL/acre
1 L/ha = 400 mL/acre (0.4 L acre)
2 L/ha = 800 mL/acre (0.8 L/acre)
3 L/ha = 1.2 L/acre
4 L/ha = 1.6 L/acre
5 L/ha = 2 L/acre
10 L/ha = 4 L/acre
20 L/ha = 8 L/acre
30 L/ha = 12 L/acre
40 L/ha = 16 L/acre
50 L/ha = 20 L/acre
100 L/ha = 40 L/acre
500 L/ha = 200 L/acre
1000 L/ha = 400 L/acre

SPRAYING RECORD

CROP OR FIELD NO.	DATE	MATERIAL USED	RATE & AMOUNT	NOTES (Weather etc.)

SPRAYING RECORD

CROP OR FIELD NO.	DATE	MATERIAL USED	RATE & AMOUNT	NOTES (Weather etc.)

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